Staff Report of the

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

CENTRAL VALLEY REGION

AGRICULTURAL DRAINAGE CONTRIBUTION TO WATER QUALITY IN THE GRASSLAND AREA OF WESTERN MERCED COUNTY, CALIFORNIA: OCTOBER 1990 TO SEPTEMBER 1991

(WATER YEAR 1991)

JULY 1992

DISCLAIMER

This publication is a technical report by staff of the California Regional Water Quality Control Board, Central Valley Region. No policy or regulation is either expressed or intended.

3443 Routier Road, Suite A
Sacramento, California 95827-3098

Phone: (916) 361-5600
CALNET: 8-495-5600

The staff involved in the preparation of this report are:

Dennis W. Westcot, Senior Land and Water Use Analyst
Jeanne E. Chilcott, Associate Land and Water Use Analyst
Tim S. Wright, Geology Assistant

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

EXECUTIVE SUMMARY AND RECOMMENDATIONS

SUMMARY

In May 1985, Regional Board staff began a water quality monitoring program to evaluate the effects of subsurface agricultural drainage on the water quality of the drains in the Grassland Area of western Merced County. This database is used in the development and evaluation of future agricultural drainage reduction programs in the San Joaquin River Basin. Reports on this water quality survey have already been prepared and approved by the Board for May 1985 through September 1990. The current report covers October 1990 through September 1991, a critically dry Water Year.

Agricultural lands east, west, and south of the Grassland Area discharge subsurface agricultural drainage water (tile drainage) and surface runoff (irrigation tailwater) to the Grassland Area. This drainage often contains high concentrations of salts, selenium, and other trace elements. This regional drainage flows north through the Grassland Area where it is carried by a network of canals which can divert water in a number of possible ways before it reaches Mud Slough (north) or Salt Slough and ultimately the San Joaquin River.

The current study shows that the highest constituent concentrations are found at the inflow monitoring stations near the southern boundary of the study area. This inflow water is generally a blend of subsurface tile drainage and surface runoff (tailwater) or operational spills from irrigation canals. Four of these inflow points carry a substantial portion of subsurface drainage water that has the highest concentrations of salts, boron, and selenium. Other inflows contain little selenium; however, elevated levels of salt and boron are present.

The two main outflows, Mud Slough (north) and Salt Slough, were monitored during the study. These sites represent water quality of the blended drainage flowing from the Grassland Area to the San Joaquin River. The quality of both sloughs varied widely depending upon which slough was carrying the greatest portion of subsurface tile drainage water. The median selenium concentration for Salt Slough was higher than that of Mud Slough although a wide range of variability was detected. For example, Salt Slough selenium concentrations ranged from 0.9 to 34 μg/L with a median of 15 μg/L. Mud Slough showed a similar variability with a median selenium value of 2.4 μg/L. Concentrations for all the drains and sloughs were routinely higher during the critical Water Years 1987-91 than they were during the wet Water Year 1986. Seasonal variations in constituent concentrations occurred in Water Year 1991 in a manner similar to the previous four Water Years, with the highest levels occurring during the non-irrigation season (October to March).

Water quality objectives for selenium, and boron are scheduled for compliance in 1993. Molybdenum objectives are in place on the Sloughs. Milestones have been included for selenium for WYs 91 and 92 to evaluate progress toward meeting the objective.

During WY 91, the 1993 monthly mean molybdenum objective (19 μg/L) was exceeded six out of twelve months in Mud Slough but was not exceeded at any time in Salt Slough. In contrast, the 1993 mean monthly boron objective (2.0 mg/L) was consistently exceeded in both sloughs during WY 91.

The selenium milestone for WY 91 (17 μg/L) was exceeded between December and June 1991 in Salt Slough with the maximum monthly mean reaching 24 μg/L. Mud Slough exceeded the 1991 selenium milestone in July, August, and September.

The upcoming 1993 water quality objective for selenium (10 μg/L) was exceeded during WY 91 by both Mud Slough (north) and Salt Slough. Continuing drought conditions during WY 92 may increase difficulties in meeting future milestones and objectives for both sloughs.

The monthly mean concentrations of boron, molybdenum, and selenium will continue to be reviewed in future water years.

INTRODUCTION

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program in May of 1985 to evaluate the effects of subsurface agricultural drainage on the water quality of the drains in the Grassland Area in western Merced County. The study area is located west of the San Joaquin River between Newman and Oro Loma, California (Figure 1). The purpose of this monitoring program is to compile an on-going database for selected inorganic constituents found in the agricultural drains discharging to and flowing through the Grassland Area. This database is used in the development and evaluation of an agricultural drainage reduction program in the San Joaquin River Basin. This report contains laboratory results and a brief summary of the water quality analysis for samples collected from October 1990 through September 1991. Four previous reports (James, *et al.*, 1988, Chilcott, *et al.*, 1989, Westcot, *et al.*, 1990, and Westcot, *et al.*, 1991) present data for the period May 1985 through September 1990. This report is a discussion of the entire Water Year (WY) 91 which extends from 1 October 1990 through 30 September 1991.

STUDY AREA

The Grassland Area is composed of the Northern and Southern Divisions of the Grassland Water District and the farmlands adjacent to the District (Figure 1). Land in this area is primarily used for agriculture and seasonal wetlands for wildlife.

Agricultural lands east, west, and south of the Grassland Area discharge subsurface agricultural drainage water (tile drainage) and surface runoff (irrigation tailwater) to the Grassland Area. This drainage often contains high concentrations of salts, selenium, and other trace elements. This regional drainage flows north through the Grassland Area where it is carried by a network of canals which can divert water in a number of possible ways before it reaches Mud Slough (north) or Salt Slough and ultimately the San Joaquin River.

There were 32 stations in the Grassland monitoring program as described by James, *et al.*, 1988. They were divided into three categories: inflows to, internal flows within, and outflows from the Grassland Area. Inflow monitoring stations were located on drains that discharge into the Grassland area and are mainly located at the southern end of the study area. Monitoring stations on the internal flow canals were located on drains within the Grassland Area that carry or could carry subsurface tile drainage as it passes through the area before discharging to the San Joaquin River. Outflow monitoring stations were located where drains or natural waterways flow out of the Grassland Area. Many of the internal flow stations described by James, *et al.* (1988), have been dropped from the monitoring program due to the large effect management plays in their water quality. The present report concentrates on the inflow and outflow stations. A list of the monitoring stations is shown in Table 1. Stations which have continuous data from May 1985 through September 1991 have been highlighted. The remaining stations were dropped from the monitoring program prior to October 1989, with the corresponding data reported in James, *et al.*, 1988, Chilcott, *et*

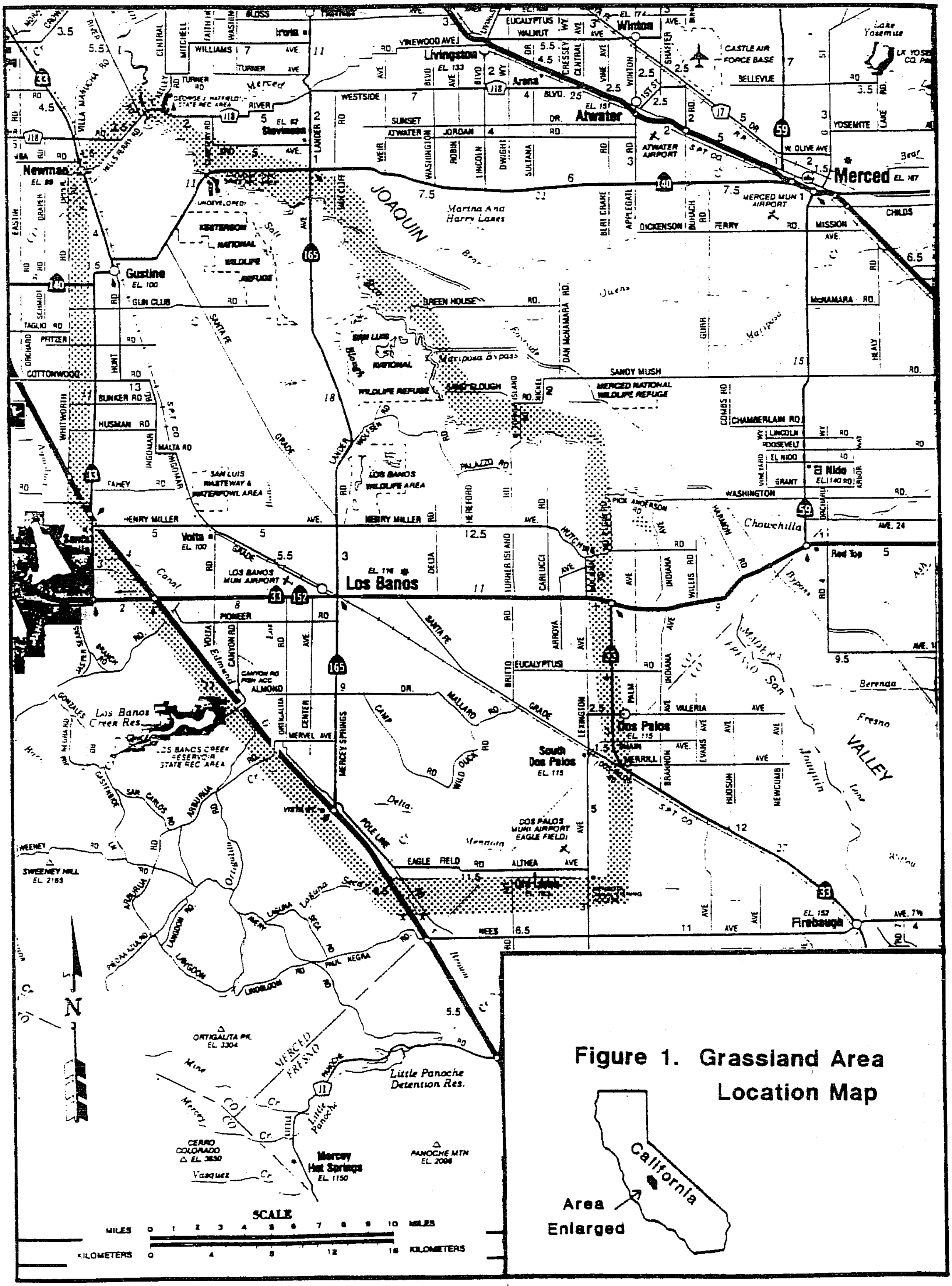


Figure 1. Grassland Area Location Map

al., 1989 and Westcot, *et al.*, 1990. In this study, there are 11 inflow, 2 internal flow, and 5 outflow monitoring stations. The two internal flow stations are maintained to assess the approximate concentration of selenium in the two main water supply source canals to the Grassland Area. Table 1 also identifies the map index number for each site as shown on the location map in Figure 2.

Table 1. Water Quality Monitoring Sites in the Grassland Area (adapted from James et al., 1988, and Chilcott et al., 1989).

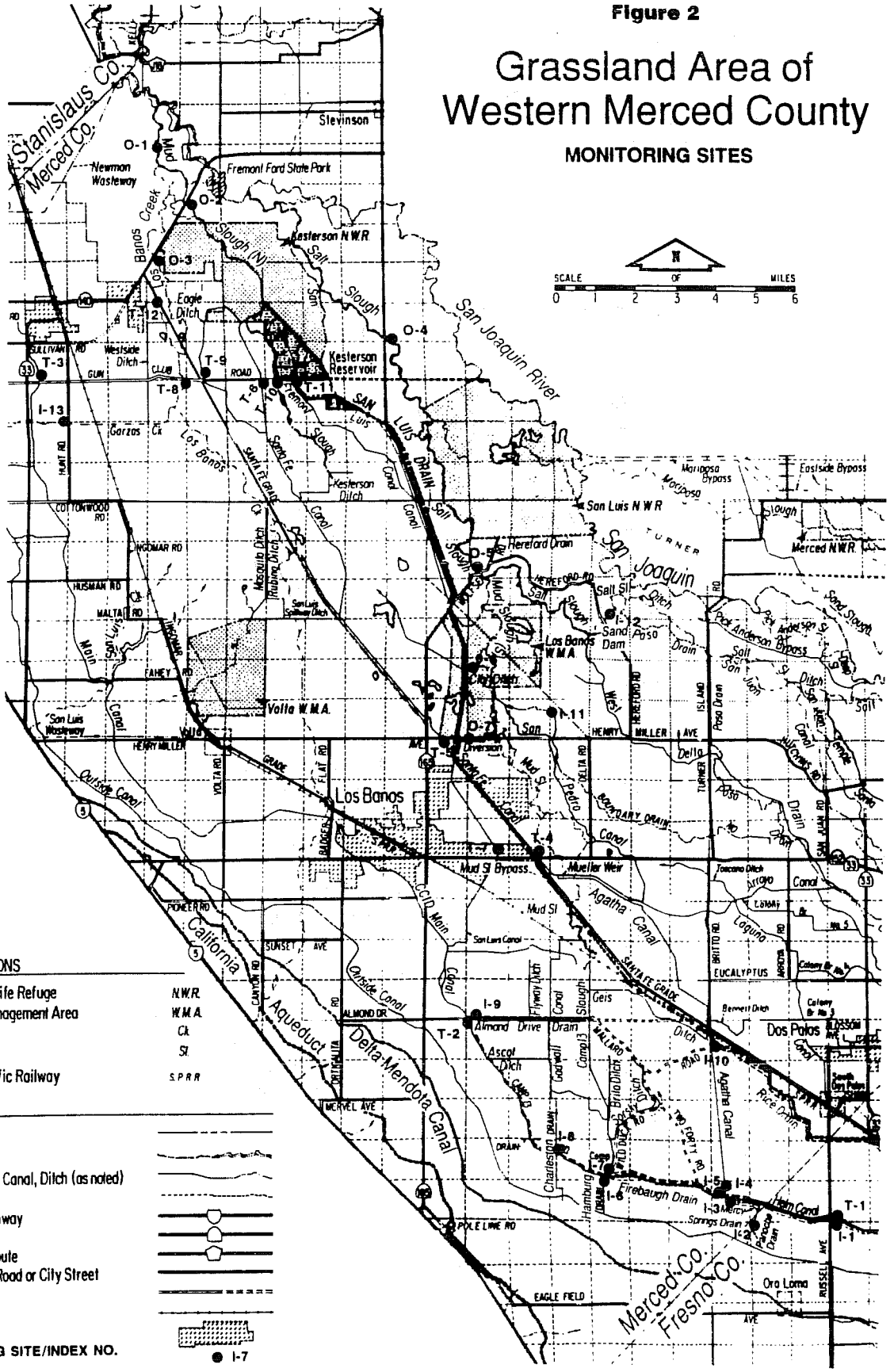
Map Index	RWQCB Site I.D.	Site Name	Site Type
I-1	**MER556**	**Main (Firebaugh) Drain @ Russell**	**Inflow**
I-2	**MER501**	**Panoche Drain**	**Inflow**
I-3	**MER552**	**Agatha Inlet (Mercy Springs) Drain**	**Inflow**
I-4	**MER506**	**Agatha Canal**	**Inflow**
I-5	MER507	Helm Canal	Inflow
I-6	**MER504**	**Hamburg Drain**	**Inflow**
I-7	**MER505**	**Camp 13 Slough**	**Inflow**
I-8	**MER502**	**Charleston Drain**	**Inflow**
I-9	**MER555**	**Almond Drive Drain**	**Inflow**
I-10	**MER509**	**Rice Drain**	**Inflow**
I-11	**MER521**	**Boundary Drain**	**Inflow**
I-12	**MER528**	**Salt Slough Ditch @ Hereford Road**	**Inflow**
I-13	MER513	Garzas Creek @ Hunt Road	Inflow
T-1	**MER510**	**CCID Main @ Russell Avenue**	**Internal Flow**
T-2	MER511	CCID Main @ Almond Drive	Internal Flow
T-3	MER512	CCID Main @ Gun Club Road	Internal Flow
T-4	MER540	Santa Fe Canal @ HWY 152	Internal Flow
T-5	MER519	Santa Fe Canal @ Henry Miller Rd.	Internal Flow
T-6	MER517	Santa Fe Canal @ Gun Club Rd.	Internal Flow
T-7	**MER527**	**San Luis Canal @ HWY 152**	**Internal Flow**
T-8	MER514	Los Banos Creek @ Gun Club Rd.	Internal Flow
T-9	MER518	Eagle Ditch	Internal Flow
T-10	MER516	Mud Slough (North) @ Gun Club Rd.	Internal Flow
T-11	MER515	Freemont Canal @ Gun Club Rd.	Internal Flow
T-12	MER553	Gustine Sewage Treatment Plant Ditch	Internal Flow
O-1	**MER551**	**Mud Slough (N) @ Newman Gun Club**	**Outflow**
O-2	MER541	Mud Slough (N) @ HWY 140	Outflow
O-2A	**MER542**	**Mud Slough (N) @ San Luis Drain**	**Outflow**
O-3	**MER554**	**Los Banos Creek @ HWY 140**	**Outflow**
O-4	**MER531**	**Salt Slough @ Lander Avenue**	**Outflow**
O-5	MER530	Salt Slough @ Wolfsen Road	Outflow
O-6	**MER543**	**City Ditch**	**Outflow**
O-7	MER548	Santa Fe Canal-Mud Slough Diversion	Outflow

Bold print indicates that site has data for WY 91

Figure 2

Grassland Area of Western Merced County

MONITORING SITES



ABBREVIATIONS

National Wildlife Refuge	N.W.R.
Waterfowl Management Area	W.M.A.
Creek	Ck.
Slough	Sl.
Southern Pacific Railway	S.P.R.R.

LEGEND

- County Line
- River
- Creek, Slough, Canal, Ditch (as noted)
- Drain
- Interstate Highway
- State Highway
- County Sign Route
- Major County Road or City Street
- Other Roads
- Railroad
- City, Town
- **MONITORING SITE/INDEX NO.** ● I-7

METHODS

The frequency of sample collection for this phase of the monitoring program varied, but generally grab samples were collected during the first week of each month and were analyzed for total recoverable selenium, boron, chloride, sulfate, hardness and electrical conductivity (EC). Because of the continued drought conditions throughout WY 91, weekly sampling was conducted at outflow sites 0-2, 0-2A and 0-4 (Table 1). Weekly samples were also collected at all sites during the period May - Sept 1991. Selected inflow and outflow monitoring sites were also sampled for total recoverable copper, chromium, lead, molybdenum, nickel, and zinc. Water temperature, pH, EC, and sample time were recorded in the field for each site. All samples were collected in polyethylene bottles. All the selenium and trace element sample bottles were washed and acid rinsed in the laboratory prior to use. All sample bottles were rinsed three times with the water to be sampled prior to sample collection. Selenium and trace element samples were preserved by lowering the pH to less than 2 using ultra-pure nitric acid fixation techniques. All samples were kept on ice until preservation or submittal to the laboratory.

A quality control and quality assurance program was conducted utilizing spike and duplicate samples in the laboratory. In addition, blind replicate samples were collected at 10 percent of the sites, and 50 percent of the blind replicates were spiked for laboratory quality assurance. Reported results fall within quality assurance tolerance guidelines outlined in Regional Board laboratory quality control files.

RESULTS

Following the trend found in other WYs, the highest concentrations of the measured constituents were found at the inflow monitoring stations near the southern boundary of the study area. Concentrations at the internal flow and outflow monitoring stations were comparable to each other and were substantially lower than the southern inflows. Water quality analysis results at the inflow, internal flow, and outflow monitoring stations will be discussed separately.

Water quality results for both minerals and trace elements are listed by site in Appendices A through C; Grassland inflows (Appendix A), internal flows (Appendix B), and outflows (Appendix C). The ranges, mean and median values for each measured constituent at each site are also shown in these appendices. For this study, electrical conductivity (EC) represented relative salinity; while boron, chloride, and sulfate were the primary mineral constituents of concern. Selenium and molybdenum were the primary trace elements of concern. The median mineral and trace element values at each inflow monitoring station are listed in Table 2 for WY 91.

Table 2. Median Constituent Concentrations for Grassland Area Drains During WY 91 (10/90 through 9/91).

Map ID	Monitoring Site	EC	Median Constituent Concentrations												
		umhos/cm	B	Cl	SO4	Hardness	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V
			mg/L				ug/L								
	Inflow Sites														
I-1	Main (Firebaugh) Drain @ Russell	3450	4.6	440	1400	940	52	21	10	23	<5	21	18	16	12
I-2	Panoche Drain/O'Banion	4450	7.5	620	1300	1200	64	8	3	20	<5	7	7	11	7
I-3	Mercy Springs Drain (Agatha Main Drain)	3770	6.4	655	1095	985	4.7								
I-4	Agatha Canal	4295	6.6	515	1100	1025	53	9							
I-6	Hamburg Drain	5540	5.6	730	1675	1650	99	7	1	11	1	<5	<5	19	6
I-7	Camp 13 Slough	3958	5.5	560	1300	1200	55	21							
I-8	Charleston Drain	4370	4.2	645	1700	1600	60	8	3	10	<5	7	11	20	
I-9	Almond Drive Drain	1415	1.0	200	250	335	2.9								
I-10	Rice Drain	2640	4.7	420	1145	860	2.6	22							
I-11	Boundary Drain	1420	0.44	233	175	280	0.8								
I-12	Salt Slough/Hereford	1045	0.30	180	130	260	0.9								
	Internal Flow Sites														
T-1	CCID Main Canal/Russell	710	0.27	135	86	150	1.5								
T-7	San Luis Canal/HWY 152	1625	1.6	260	455	520	2.6								
	Outflow Sites														
O-1	Mud Slough / NGC	3540	3.2	540	905	780	3.9	15							
O-2A	Mud Slough/San Luis Drain	4030	4.4	640	1000	820	2.4	27	3	5	<5	6	5	7	10
O-3	Los Banos Creek/HWY 140	2745	1.6	490	495	605	1.0	14							
O-4	Salt Slough/Lander Ave.	2460	2.0	335	370	455	15	11	2	3	<5	<5	5	12	6
O-6	City Ditch	3550	5.1	400	950	740	41								

All results are reported as total recoverable

Minerals

Inflow Monitoring Stations:

The inflow monitoring stations represent the quality of the agricultural drainage entering the Grassland Area. The first ten monitoring stations (I-1 to I-10) listed in Table 2 represent inflow into the South Grassland Area. The remaining three inflow stations (I-11 to I-13) either discharge to sloughs or the North Grassland Area (Figure 2).

Continuing the trend found in previous WYs, the inflows that carry a substantial portion of subsurface drainage water, the Main (Firebaugh) (I-1), Panoche (I-2), Agatha Inlet (Mercy Springs) (I-3), Hamburg (I-6), and Charleston Drains (I-8), had elevated salinity levels. Hamburg Drain had the highest median EC (5540 μmhos/cm), chloride (730 mg/L) and harness (1650 mg/L) values. Panoche drain had the highest median boron (7.5 mg/L) value, and Charleston Drain had the highest sulfate value (1700 mg/L).

Internal Flow Monitoring Stations:

The internal flow monitoring stations were located on drains that carry or could carry subsurface agricultural drainage as it passes through the Grassland Area. Only two of the original internal flow monitoring stations, the CCID Main at Russell Avenue (T-1) and the San Luis Canal at Highway 152 (T-7), were monitored during WY 91. These two stations represent concentrations in the main water supply source canals to the Grassland Area. The median EC, boron, chloride, and sulfate values recorded during this study for each of the internal flow monitoring stations are listed in Table 2.

Outflow Monitoring Stations:

Mud Slough (north) and Salt Slough are the only two tributaries to the San Joaquin River which drain the Grassland Area and are described in detail by James, *et al.* (1988), Pierson, *et al.* (1989a and 1989b). Mud Slough (north) at the San Luis Drain (O-2A) and Salt Slough at Lander Avenue (O-4) are the principal stations in this monitoring program. These two sites best represent the water quality of the drainage leaving the Grassland Area. Los Banos Creek at Hwy 140 (O-3) drains into Mud Slough (north) upstream of the San Joaquin River. Mud Slough at Newman Gun Club (O-1) represents the combined quality of Mud Slough (north) and Los Banos Creek. During this study, Mud Slough (north) at the San Luis Drain (O-2A) had EC values ranging from 870 to 9710 μmhos/cm with a median of 4030 μmhos/cm. Boron at this site ranged from 0.46 to 6.4 mg/L with a median value of 4.4 mg/L.

Salt Slough at Lander Avenue (O-4) is the last monitoring station before Salt Slough discharges to the San Joaquin River. During this study, Salt Slough at Lander Avenue had EC values ranging from 1020 to 3970 μmhos/cm with a median value of 2460 μmhos/cm, and boron values ranging from 0.32 to 4.6 mg/L with a median of 2.0 mg/L (Appendix C). As seen in WYs 89 and 90 (Westcot, *et al.*, 1990 and 1991), EC and boron concentrations at this site were less variable than in previous WYs because of the continuous use of this slough to divert drainage to the San Joaquin River. Concentrations at this site are generally lower than the

South Grassland inflow monitoring stations due to additional dilution that occurs as the drainage water moves further downstream within the Grassland Area. Median concentrations for salinity and boron were lower in Salt Slough than in Mud Slough (north).

Trace Elements

Although selenium was monitored at every site and molybdenum at a majority of sites, analyses of additional trace elements were limited based on the overall low concentrations found by James, *et al.* (1988). Total recoverable selenium, molybdenum, copper, chromium, lead, nickel, and zinc are listed in Appendices A through C for inflow, internal flow, and outflow monitoring stations, respectively. The ranges mean and median concentrations for the trace elements measured at each station are also listed in these appendices. The median trace element concentrations at each station for WY 90 are tabulated in Table 2.

Inflow Monitoring Stations:

The highest median trace element concentrations occurred at the South Grassland inflow stations (I-1 to I-10), where the median selenium values ranged from 2.6 μg/L at Rice Drain (I-10) to 99 μg/L at Hamburg Drain (I-6). The Main (I-1), Panoche (I-2), Hamburg (I-6), and Charleston (I-8) Drains had high median selenium concentrations; however, as with salinity and boron discussed earlier, the concentrations are highly dependent upon the amount of dilution water in the canal or drain at the time of sampling. Due to the continued drought, total recoverable selenium concentrations have been found in excess of 100 μg/L at the Main Drain (4 times), Charleston Drain (2 times), Hamburg Drain (13 times), and Panoche Drain (3 times), indicating that little surface runoff was available for dilution at that time. These higher concentrations occurred primarily during the non-irrigation season (October - March) when drainage flows were very low and dilution water was scarce except in the Hamburg Drain where these levels occurred continuously throughout the irrigation season. Inflow sites which carry drainage from Sierra Nevada deposits (Rice Drain, Boundary Drain and Salt Slough at Hereford) continue to contain the lowest median selenium concentrations.

The Main Drain (I-1) and Rice Drain (I-10) had the highest median molybdenum concentrations at 21 μg and 22 μg/L, respectively. The remaining inflow drains had median molybdenum concentrations ranging from 7 μg/L to 9 μg/L.

In addition to selenium and molybdenum, copper, chromium, nickel, lead, uranium, vanadium and zinc were analyzed at the four major subsurface drainage inflows (Main, Panoche, Hamburg and Charleston Drains). Only chromium, uranium and vanadium appear consistently elevated (Table 2).

Internal Flow Monitoring Stations:

Selenium was the only trace element measured at both internal flow monitoring stations. From October 1990 through September 1991, CCID Main Canal at Russell Avenue (T-1) had selenium concentrations ranging from 0.6 μg/L to 5 μg/L with a median concentration of 1.5 μg/L. During the same period, selenium concentrations at San Luis Canal at Hwy 152 (T-7) ranged from 0.9 μg/L to 5.0 μg/L with a median concentration of 2.6 μg/L.

Outflow Monitoring Stations:

Selenium was monitored at all five outflow stations, molybdenum was monitored at four stations (0-1, 0-2, 0-2A and 0-4), and copper, chromium, nickel, lead, and zinc were monitored at two outflow stations (0-2A and 0-4) on a limited basis. The median trace element concentrations detected during this study are tabulated in Table 2.

The outflow monitoring stations, as mentioned earlier, are related to one of two tributaries of the San Joaquin River; the outflow through Salt Slough (site 0-4) and those that outflow through Mud Slough (north), (sites 0-1 through 0-3) as described in Table 1.

Selenium concentrations at the furthest downstream monitoring station on Salt Slough at Lander Avenue (0-4), ranged from 0.9 to 34 μg/L with a median of 15 μg/L.

Selenium concentrations at Mud Slough (north) at the San Luis Drain (0-2A) ranged from 0.5 to 43 μg/L with a median of 2.4 μg/L. Los Banos Creek flows into Mud Slough (north) downstream of the Highway 140 monitoring station and it has a diluting effect on the Slough with respect to selenium, as measured at the Newman Land and Cattle Company station (0-1). Los Banos Creek receives its flow from the western portion of the North Grassland Area and from areas west of the study area. The creek receives little subsurface drainage. In WY 91, selenium concentrations range from 0.4 to 3.0 μg/L with a median of 1.0 μg/L at the Los Banos Creek at Highway 140 station (0-3). The downstream Mud Slough (north) station (0-1) had selenium concentrations ranging from 0.7 to 31 μg/L and a median of 3.9 μg/L.

DISCUSSION

The current study shows that water quality within the Grassland Area continues to vary widely with the highest constituent concentrations found at the inflow monitoring stations near the southern border of the study area. This inflow water is generally a blend of subsurface tile drainage and surface runoff (tailwater) or operational spills from irrigation canals. Four of these inflow points (I-1, I-2, I-6, and I-8) carry a substantial portion of subsurface drainage water. The highest concentrations at these four sites likely reflect a greater proportion of tile drainage in the flow and not necessarily the quality of subsurface drainage being discharged at the tile drainage sumps. The sites inflowing from the south and southeast continue to carry the highest concentrations of salts, boron, and selenium. Other inflows contain little selenium; however, elevated levels of salt and boron are present. For example, the median values for selenium at the four major southern inflow points ranged from 52 to 99 μg/L while other southern inflow points showed median selenium values ranging from 2.6 to 4.7 μg/L. The three canals which carry drainage from Sierran deposits (I-10, I-11 and I-12) continue to show the lowest selenium concentrations with medians ranging from 0.8 μg/L to 2.6 μg/L. For boron, however, the four drains carrying the high selenium water showed median boron values ranging from 4.2 to 7.5 mg/L while the other inflow drains that have low selenium values showed median boron values ranging from 1.0 to 6.4 mg/L.

Concentration at the internal flow and outflow monitoring stations were comparable to each other and were substantially lower than the southern inflows. The water quality reflects the amount of mixing and dilution that takes place as drainage water moves through the Grassland Area. The flows are strongly regulated by an extensive system of man-made structures and trends in water quality are difficult to identify.

Data in this report covers Water Year 1991 (WY 91). WY 91 is the fifth consecutive critically dry water year. Tabulated in Table 3 are median constituent concentrations by water year for all the monitoring sites since 1985. Median concentrations were listed for WY 85 where available; however, the 1985 data set may be incomplete for some locations. Concentrations for all the drains and sloughs were routinely higher during the critically dry Water Years 1987-91 than during the wet Water Year 1986. The elevated concentrations may be due in part to increased influence of the shallow groundwater, as well as a decrease in dilution from irrigation spill water or tail water runoff. The decrease in irrigation spill water or tail water may be due to more efficient use of limited supply water.

Table 3. Median Constituent Concentrations for Grassland Area Drains During Water Years 85, 86, 87, 88, 89, 90, and 91 (Data for WY's 85, 86, and 87 from James et al., 1988, for WY 88 from Chilcott et. al., 1989, and for WY's 89 and 90 from Westcot et al., 1991.

Map ID	Monitoring Site / Water Year	Median Constituent Concentrations umhos/cm EC	B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn	U	V
			mg/L			ug/L								
I-1	Main (Firebaugh) Drain @ Russell													
	Dry WY 85	2400	3.2	230	693	35	--	--	--	--	--	--	--	--
	Wet WY 86	2700	3.5	250	900	46	14	16	9	27	--	14	--	--
	Critical WY 87	2600	3.4	270	630	42	9	19	9	22	--	28	--	--
	Critical WY 88	3000	3.6	320	790	49	10	22	12	22	<5	29	--	--
	Critical WY 89	2980	3.9	315	835	49	13	17	9	19	<5	23	--	--
	Critical WY 90	3400	4.6	370	1200	52	24	10	5	11	<5	13	--	--
	Critical WY 91	3450	4.6	440	1400	52	21	10	23	<5	21	18	16	12
I-2	Panoche Drain/O'Banion													
	Dry WY 85	3500	6.5	460	985	38	3	--	--	--	--	--	--	--
	Wet WY 86	3400	5.8	390	800	56	6.1	26	5.5	15	--	15	--	--
	Critical WY 87	4375	7.8	550	1075	47	2.5	40	10	13	--	18	--	--
	Critical WY 88	3650	6.4	440	890	54	3	43	12	21	<5	29	--	--
	Critical WY 89	4180	6.5	520	1000	69	6	32	5	8.0	<5	11	--	--
	Critical WY 90	4550	7.5	665	1400	72	8	32	4	9	<5	10	--	--
	Critical WY 91	4450	7.5	620	1300	64	8	3	20	<5	7	7	11	7
I-3	Mercy Springs Drain (Agatha Inlet Drain)													
	Dry WY 85	--	--	--	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	3300	7.2	360	1000	14	10	7	5	13	--	10	--	--
	Critical WY 87	3125	7.0	302	800	6	16	5	3	7	--	3	--	--
	Critical WY 88	4150	8.6	540	1300	7.9	39	10	5	15	<5	12	--	--
	Critical WY 89	3655	7.6	435	895	6.7	–	–	–	–	–	–	--	--
	Critical WY 90	4910	8.4	640	1400	7.9	–	–	–	–	–	–	--	--
	Critical WY 91	3770	6.4	655	1095	4.7	–	–	–	–	–	–	--	--
I-4	Agatha Canal													
	Dry WY 85	2600	4.9	315	1100	26	1	--	--	--	--	--	--	--
	Wet WY 86	3300	5.6	400	900	44	<5	13	9	21	--	16	--	--
	Critical WY 87	3305	5.6	410	760	38	6	22	7	12	--	12	--	--
	Critical WY 88	3550	5.6	430	895	39	3	--	--	--	--	--	--	--
	Critical WY 89	880	0.36	130	100	2.9	2	–	–	–	–	–	--	--
	Critical WY 90	4040	6.6	480	1100	26	8	–	–	–	–	–	--	--
	Critical WY 91	4295	6.6	515	1100	53	9	–	–	–	–	–	--	--

Table 3 cont. Median Constituent Concentrations for Grassland Area Drains During Water Years 85, 86, 87, 88, 89, 90 and 91 (Data for WY's 85, 86, and 87 from James et al., 1988, for WY 88 from Chilcott et. al., 1989, and for WY's 89 and 90 from Westcot et al., 1991.).

Map ID	Monitoring Site / Water Year	Median Constituent Concentrations umhos/cm EC	B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn	U	V
			mg/L			ug/L								
I-6	Hamburg Drain													
	Dry WY 85	3200	3.8	435	900	47	6	--	--	--	--	--	--	--
	Wet WY 86	3250	4.0	400	1000	51	4	13	5	10	--	13	--	--
	Critical WY 87	3345	3.7	420	925	58	<5	17	5	8	--	10	--	--
	Critical WY 88	3600	4.1	450	1050	56	4.5	11	5	<5	<5	6	--	--
	Critical WY 89	5120	5.7	660	1500	95	5	16	2	<5	<5	6	--	--
	Critical WY 90	4740	5.4	720	1400	84	5	14	1	<5	<5	6	--	--
	Critical WY 91	5540	5.6	730	1675	99	7	1	11	1	<5	<5	19	6
I-7	Camp 13 Slough													
	Dry WY 85	2550	3.4	280	745	32	4	--	--	--	--	--	--	--
	Wet WY 86	2950	3.9	375	905	43	<5	14	7	20	--	16	--	--
	Critical WY 87	2650	3.7	280	590	43	6	30	11	13	--	19	--	--
	Critical WY 88	4400	6.2	500	1050	43	4	--	--	--	--	--	--	--
	Critical WY 89	3750	5.2	440	940	59	8	–	–	–	–	–	--	--
	Critical WY 90	3440	4.9	455	1010	54	9	–	–	–	–	–	--	--
	Critical WY 91	3960	5.5	560	1300	55	21	–	–	–	–	–	--	--
I-8	Charleston Drain													
	Dry WY 85	3900	2.6	395	1275	48	--	--	--	--	--	--	--	--
	Wet WY 86	4500	4.7	510	1580	93	7.9	9	10	14	--	18	--	--
	Critical WY 87	3855	4.2	480	1035	79	2	32	12	22	--	50	--	--
	Critical WY 88	4450	4.5	520	1300	71	3	31	13	27	--	47	--	--
	Critical WY 89	4400	3.8	520	1400	66	3	25	12	17	<5	33	--	--
	Critical WY 90	4350	3.7	525	1400	69	6	14	3	8	<5	17	--	--
	Critical WY 91	4370	4.2	645	1700	60	8	3	10	<5	7	11	20	--
	Almond Drive Drain													
	Dry WY 85	1520	1.6	160	340	2	--	--	--	--	--	--	--	--
	Wet WY 86	--	--	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 87	1925	2.1	224	395	4.8	4.5	28	11	21	--	25	--	--
	Critical WY 88	2300	2.1	230	460	4.6	--	18	7	13	--	15	--	--
	Critical WY 89	2160	2.2	190	420	3.7	–	–	–	–	–	–	--	--
	Critical WY 90	1320	0.91	155	220	2.3	–	–	–	–	–	–	--	--
	Critical WY 91	1415	1	200	250	2.9	–	–	–	–	–	–	--	--
I-10	Rice Drain													
	Dry WY 85	2450	5.7	245	715	2.5	--	--	--	--	--	--	--	--
	Wet WY 86	3300	8.1	350	1080	3	14	5	6	23	--	13	--	--
	Critical WY 87	2500	6.1	260	550	2.6	11	3	3	6	--	<1	--	--
	Critical WY 88	2790	5.1	310	700	2.6	15	--	--	--	--	--	--	--
	Critical WY 89	2745	5.4	280	673	3.1	14	--	--	--	--	--	--	--
	Critical WY 90	3050	5.4	350	855	2.7	16	--	--	--	--	--	--	--
	Critical WY 91	2640	4.7	420	1145	2.6	22	--	--	--	--	--	--	--
I-11	Boundary Drain													
	Dry WY 85	1090	0.45	195	135	1	--	--	--	--	--	--	--	--
	Wet WY 86	1710	0.65	250	210	1	6	2	7	9	--	14	--	--
	Critical WY 87	1250	0.54	200	145	1.6	4	<1	2	<5	--	3	--	--
	Critical WY 88	1470	0.50	230	180	1.4	6	--	--	--	--	--	--	--
	Critical WY 89	1435	0.53	240	190	1.0	–	--	--	--	--	--	--	--
	Critical WY 90	1500	0.44	250	175	0.9	–	–	–	–	–	–	--	--
	Critical WY 91	1420	0.44	233	175	0.8	–	–	–	–	–	–	--	--
I-12	Salt Slough @ Hereford													
	Dry WY 85	850	0.37	120	100	1	--	--	--	--	--	--	--	--
	Wet WY 86	785	0.33	100	99	1	<5	3	5	9	--	22	--	--
	Critical WY 87	1000	0.39	130	120	1.4	3	1	2	<5	--	2	--	--
	Critical WY 88	1150	0.38	160	140	1.2	5	--	--	--	--	--	--	--
	Critical WY 89	1070	0.36	160	140	1.2	–	--	--	--	--	--	--	--
	Critical WY 90	1030	0.30	160	110	0.6	–	--	--	--	--	--	--	--
	Critical WY 91	1045	0.30	180	130	0.9	–	--	--	--	--	--	--	--

Table 3 cont. Median Constituent Concentrations for Grassland Area Drains During Water Years 85, 86, 87, 88, 89, 90 and 91 (Data for WY's 85, 86, and 87 from James et al., 1988, for WY 88 from Chilcott et. al., 1989, and for WY's 89 and 90 from Westcot et al., 1991.).

Map ID	Monitoring Site / Water Year	Median Constituent Concentrations												
		umhos/cm	B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn	U	V
		EC	mg/L			ug/L								
T-1	CCID Main Canal @ Russell													
	Dry WY 85	430	0.21	72	35	<1	--	--	--	--	--	--	--	--
	Wet WY 86	385	0.21	53	47	1.3	<5	3	3	5	--	8	--	--
	Critical WY 87	570	0.28	65	58	2.2	<5	1	3	<5	--	3	--	--
	Critical WY 88	760	0.29	120	65	1.7	--	--	--	--	--	--	--	--
	Critical WY 89	700	0.26	94	68	1.7	--	--	--	--	--	--	--	--
	Critical WY 90	680	0.32	120	93	2.3	–	--	--	--	--	--	--	--
	Critical WY 91	710	0.27	135	86	1.5	–	--	--	--	--	--	--	--
T-7	San Luis Canal @ HWY 152													
	Dry WY 85	1550	1.4	180	295	4.5	--	--	--	--	--	--	--	--
	Wet WY 86	1200	1.4	130	200	2	<5	4	4	10	--	9	--	--
	Critical WY 87	2630	3.4	260	520	4	<5	3	3	<5	--	7	--	--
	Critical WY 88	2550	3.6	280	570	3.9	--	--	--	--	<5	--	--	--
	Critical WY 89	1045	0.76	135	140	2.5	--	--	--	--	–	–	--	--
	Critical WY 90	1400	1.7	180	270	2.5	–	--	--	--	–	–	--	--
	Critical WY 91	1625	1.6	260	455	2.6	–	--	--	--	–	–	--	--
O-1	Mud Slough @ NGC													
	Dry WY 85	-	--	--	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	1800	2.0	215	330	4	5	9	5	11	--	15	--	--
	Critical WY 87	2600	2.4	300	420	5.1	13	7	4	10	--	1	--	--
	Critical WY 88	2480	2.2	330	440	4.7	--	--	--	--	--	--	--	--
	Critical WY 89	2310	1.7	325	385	2.1	--	--	--	--	--	--	--	--
	Critical WY 90	2480	2.1	335	510	4.3	10	--	--	--	--	--	--	--
	Critical WY 91	3540	3.2	540	905	3.9	15	--	--	--	--	--	--	--
O-2A	Mud Slough @ SLD													
	Dry WY 85	2600	3.1	305	525	13	--	--	--	--	--	--	--	--
	Wet WY 86	2300	3.0	280	630	8.5	8	6	5	14	--	11	--	--
	Critical WY 87	2600	3.0	320	540	17	9	12	9	11	--	7	--	--
	Critical WY 88	2820	2.7	350	510	9.3	11	--	--	--	--	--	--	--
	Critical WY 89	3000	2.4	425	480	2.1	11	10	4	<5	12	12	--	--
	Critical WY 90	3060	3.4	410	590	5.2	12	6	2	8	<5	7	--	--
	Critical WY 91	4030	4.4	640	1000	2.4	27	3	5	<5	6	5	7	10
O-3	Los Banos Ck @ HWY 140													
	Dry WY 85	--	--	--	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	2200	2.3	430	300	1	<5	6	8	18	--	17	--	--
	Critical WY 87	1855	1.6	215	215	1.4	--	--	--	--	--	--	--	--
	Critical WY 88	1690	1.2	230	210	1.1	--	--	--	--	--	--	--	--
	Critical WY 89	1630	1.0	240	200	0.9	--	--	--	--	--	--	--	--
	Critical WY 90	1870	1.2	210	290	0.8	--	--	--	--	--	--	--	--
	Critical WY 91	2745	1.6	490	495	1	14	--	--	--	--	--	--	--
O-4	Salt Slough @ Lander Ave.													
	Dry WY 85	1250	0.96	185	195	4.5	--	--	--	--	--	--	--	--
	Wet WY 86	1610	1.3	240	245	7.4	7	4	6	12	--	18	--	--
	Critical WY 87	1720	1.7	250	350	12	6	6	4	6	--	4	--	--
	Critical WY 88	1940	1.9	260	385	13	6	--	--	--	--	--	--	--
	Critical WY 89	2040	1.9	270	430	15	6	13	6	1	12	18	--	--
	Critical WY 90	2340	2.3	340	525	15	7	10	4	9	<5	15	--	--
	Critical WY 91	2460	2	335	370	15	11	2	3	<5	<5	5	12	6
O-6	City Ditch													
	Dry WY 85	2100	3.1	240	540	18	--	--	--	--	--	--	--	--
	Wet WY 86	2600	4.1	345	740	27	6	12	9	27	--	29	--	--
	Critical WY 87	3110	3.8	300	630	41	11	15	4	11	--	16	--	--
	Critical WY 88	3280	4.4	380	810	39	--	18	18	35	<5	52	--	--
	Critical WY 91	3550	5.1	400	950	41	--	--	--	--	--	--	--	--

Water Years (WY) run from 1 October through 30 September.

The two main outflows, Mud Slough (north) and Salt Slough, were monitored during the study. These sites represent water quality of the blended drainage flowing from the Grassland Area to the San Joaquin River. The quality of both sloughs varied widely depending upon which slough was carrying the greatest portion of subsurface tile drainage water. During WY 91, Salt Slough appeared to carry the greatest portion of subsurface tile drainage water based on elevated selenium concentrations. The median selenium concentration in Salt Slough (15 μg/L) was considerably higher than that in Mud Slough (2.4 μg/L). However, a wide range of variability was detected in both sloughs. For example, Salt Slough selenium concentrations ranged from 0.9 to 34 μg/L, while Mud Slough selenium concentrations ranged from 0.5 to 43 μg/L. During wet WY 86, the median boron concentration at Salt Slough at Lander Avenue was 1.3 mg/L. During the drier years, WY 87-91, median concentrations increased to 1.7 mg/L, 1.9 mg/L, 1.9 mg/L 2.3 and 2.0 mg/L, respectively.

Figures 3 through 6 present boron and selenium concentrations for Mud Slough (north) and Salt Slough for selected Water Years. As can be seen in all four figures, the time of year patterns remain similar regardless of water year type. As shown in James, *et al.* (1988), the concentrations in Salt Slough tend to increase during the non-irrigation period (October to March) and decrease during the irrigation period (April to September) (Figures 3 and 4). During the non-irrigation period, flows in the drains and canals consist mainly of shallow groundwater seepage and subsurface drainage. These two water types have been shown to contain elevated levels of a number of constituents, including boron and selenium (Lowry, *et al.*, 1989; Deverel, *et al.*, 1984; and Chilcott, *et al.*, 1988). During the irrigation season, a large proportion of the flow in the Grassland Area drains consists of surface agricultural runoff (tailwater) which dilutes the subsurface agricultural drainage, thus lowering the boron and selenium concentrations. During the non-irrigation season, there is no surface runoff, so the drains carry a higher proportion of subsurface agricultural drainage, and consequently, boron and selenium values are higher. In comparison to wet WY 86, selenium and boron concentrations in Salt Slough during critical WY 90 and WY 91 did not decrease substantially during the irrigation season. The elevated concentrations may be due in part to lack of dilution water available during the consecutively critically dry years, as well as water management directing the majority of subsurface drainage into Salt Slough rather than equally utilizing both Salt and Mud Sloughs as was practiced during WY 86.

Figure 3 and 4 shows that a significant decrease in boron and selenium concentrations occurred in Salt Slough beginning in late June and extending throughout the remainder of the water year. This resulted from the flow of subsurface drainage water being diverted from being discharged into Salt Slough. This discharged was diverted to Mud Slough (north) as shown by a subsequent rise in selenium concentration in Mud Slough (north) (Figure 6). It is interesting to note that a significant rise in boron concentration did not occur in Mud Slough (north) at the same time. The reason for this is the natural ground water seepage into the Slough is very high in salt and boron but low in selenium. Any sharp rise in selenium concentration in Mud Slough (north), therefore, denotes the presence of subsurface drainage water. Salt and boron levels, however, are similar or higher (Fig. 5) during the periods when subsurface drainage water is not present. These high natural background concentrations have only become evident in the last two water years when subsurface drainage water has been

Figure 3. Boron Concentrations in Salt Slough at Lander Avenue for WY's 86, 90, and 91.

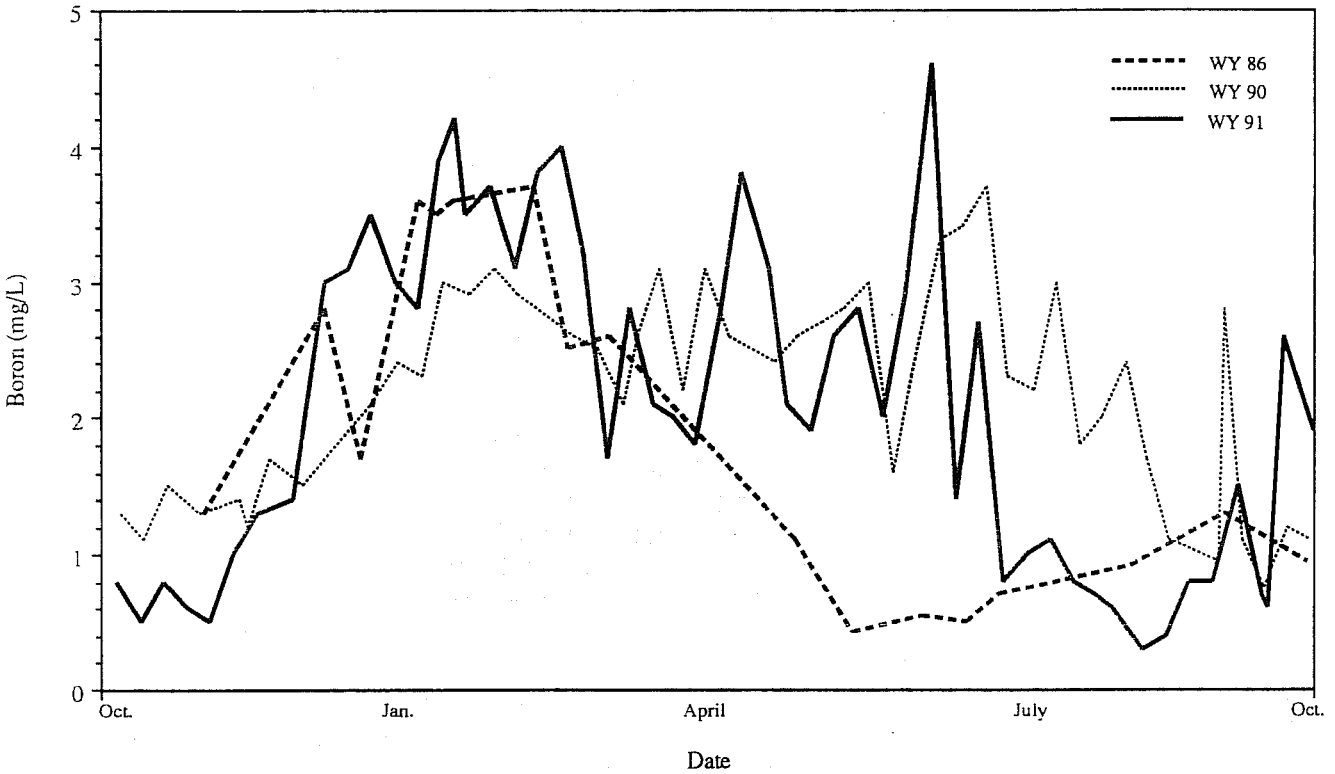


Figure 4. Selenium Concentrations in Salt Slough at Lander Avenue for WY's 86, 90, and 91.

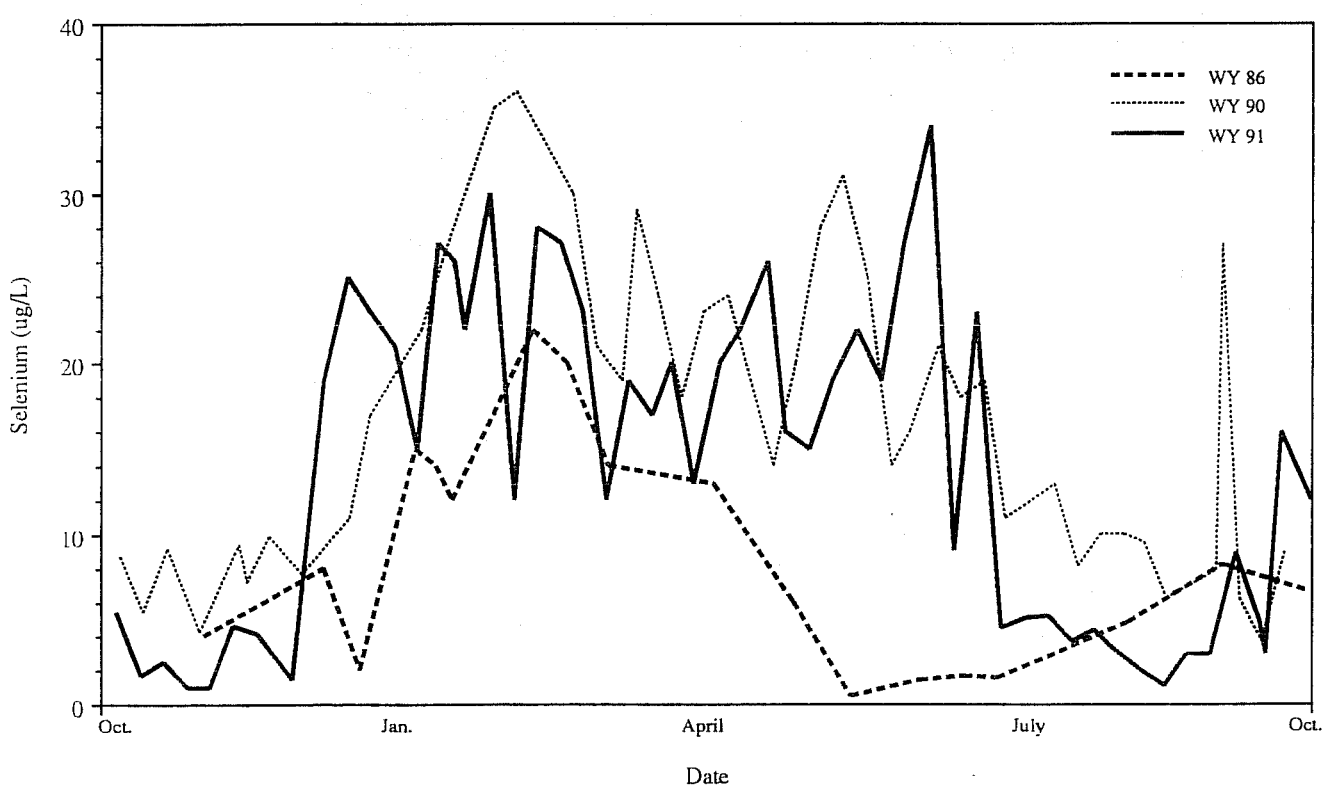


Figure 5. Boron Concentrations in Mud Slough (North) at the San Luis Drain for WY's 86, 90, and 91.

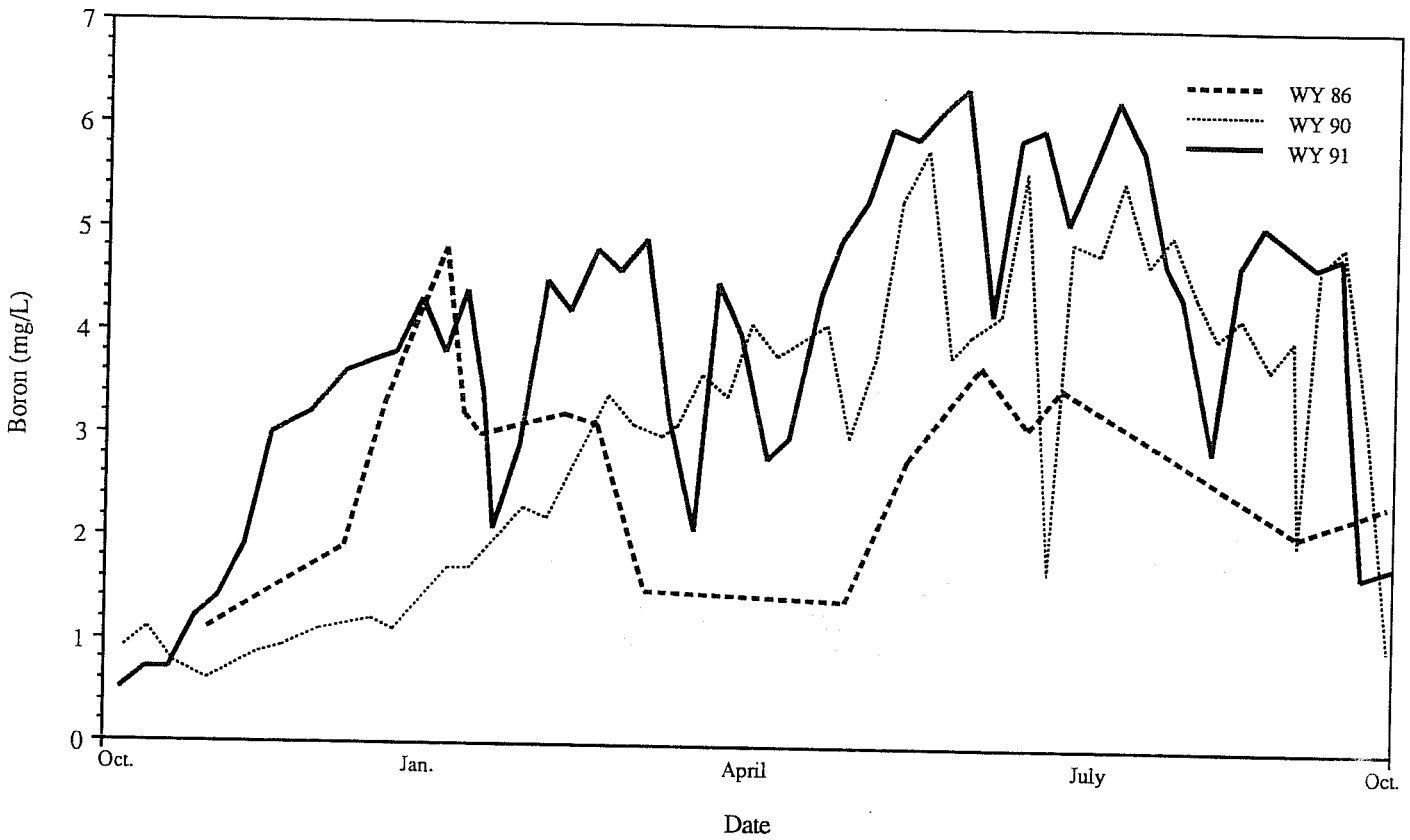
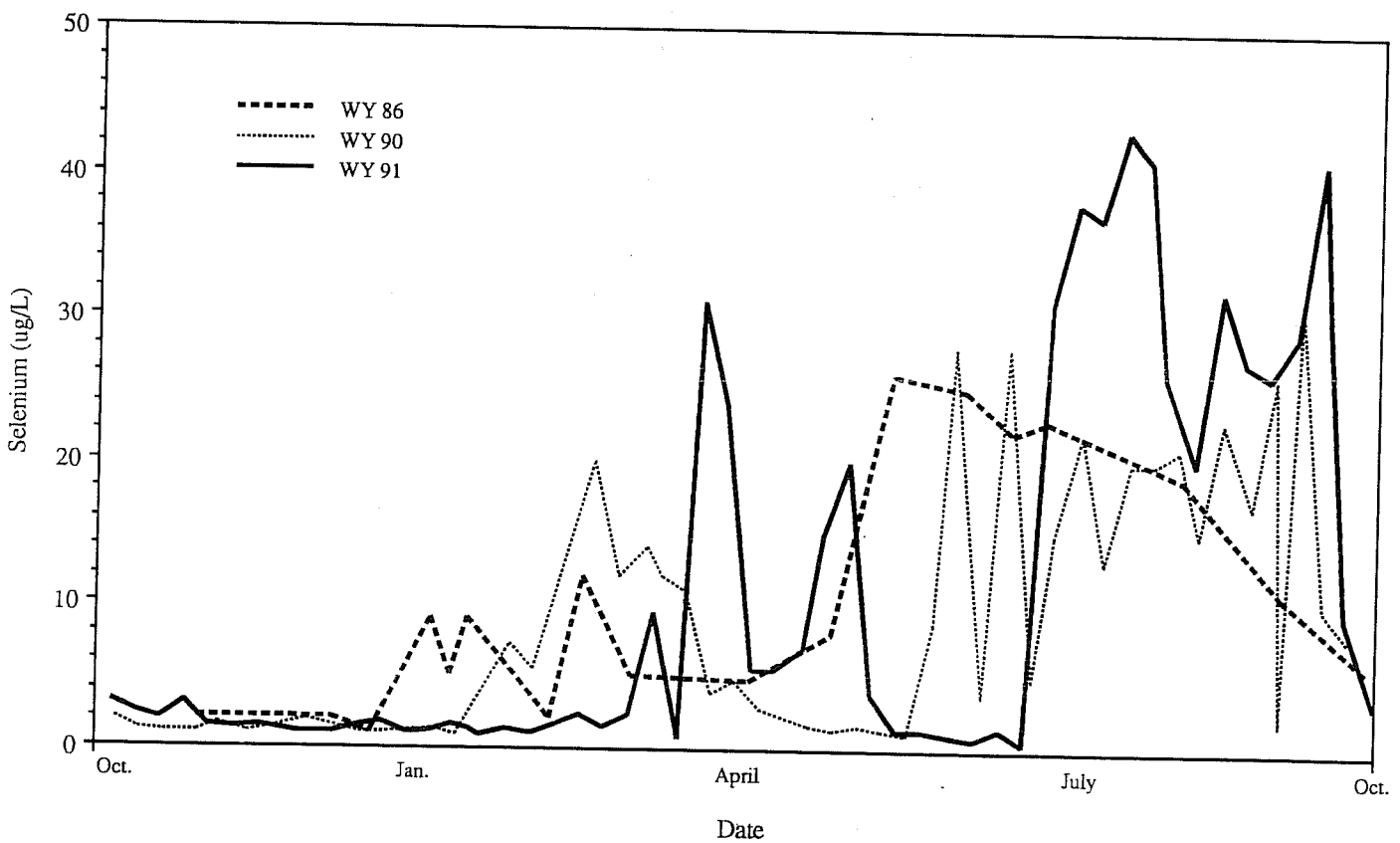


Figure 6. Selenium Concentrations in Mud Slough (North) at the San Luis Drain for WY's 86, 90, and 91.



excluded from Mud Slough (north) and surface return flows have been minimal. Similar water quality conditions have not been observed in Salt Slough, even during times when subsurface drainage water has been excluded because flow in the Slough remains dominated by agricultural surface returns flows.

Chromium continues to be an element of concern. Chromium is commonly found in shallow water in the western San Joaquin Valley, south of the study area, especially in water derived from alluvial fan deposits (Deverel, *et al.*, 1984, and Chilcott, *et al.*, 1988). The highest chromium concentrations found in this monitoring program occurred in the Main Drain and the Panoche Drain, both of which receive their flow from areas with alluvial fan deposits. Ambient water quality criteria for chromium is based on concentrations of hexavalent chromium species. This monitoring program measured total recoverable chromium; therefore, the current reported data can not be directly compared to the criteria. However, during WY 88, median values of total recoverable chromium routinely exceeded the four-day average ambient water quality criteria of 11 µg/L for the protection of freshwater aquatic life. Two of the four drains monitored had median chromium concentrations exceeding 20 µg/L, the one-hour average hexavalent chromium criteria for protection of aquatic life (EPA, 1985). All the criteria values for the protection of freshwater aquatic life are based on acid soluble metals; whereas the trace element results in this study are total recoverable concentrations. For a given sample, the total recoverable concentrations are generally higher than acid soluble concentrations (Marshack, personal communication).

COMPLIANCE WITH OBJECTIVES

In December 1988, the Regional Board adopted water quality objectives for the San Joaquin River and two of the River's tributaries, Mud Slough (north) and Salt Slough. Compliance dates were established for various concentrations of selenium, molybdenum and boron in the two sloughs (Table 4).

Table 4. Water Quality Objectives as Adopted by the Central Valley Regional Board for Mud Slough (north) and Salt Slough in the San Joaquin Basin (5C).

Constituent	Water Quality Objective		Compliance Date
Selenium	10 µg/L monthly mean	26 µg/L maximum	1993
Molybdenum	19 µg/L monthly mean	50 µg/L maximum	1990
Boron	2.0 mg/L monthly mean (15 March - 15 September)	5.8 mg/L maximum	1993

As shown in Figure 7, the mean monthly molybdenum concentration objective (19 μg/L) was not exceeded at any time in Salt Slough. Mean monthly molybdenum concentrations in Mud Slough (north) violated the established water quality objective throughout WY 91. It is interesting to note that the objective was only violated when no subsurface drainage water or wetlands releases were entering Mud Slough (north) indicating that normal seepage or background flow in the Slough contains highly elevated levels of molybdenum. Little selenium was detected in the slough during that time period which indicates an absence of subsurface drainage. The actual compliance date set to meet the objective was October 1990. The maximum concentration permitted (50 μg/L molybdenum) was not exceeded during WY 91.

The monthly mean water quality objective for boron (2.5 mg/L) was exceeded in both Mud Slough (north) and Salt Slough during WY 91 (Figure 8). Mud Slough (north) contained higher mean monthly boron concentrations. The maximum boron concentration (5.8 μg/L) was exceeded once during WY 91. Although compliance with the objective is not until 1993, this comparison was made as no interim milestones are available for boron. It should be noted that the highest boron concentrations in Mud Slough (north) were associated with periods of time when little or no subsurface drainage flow existed in the Slough. The corresponding high molybdenum and boron concentrations reflect the area's poor quality ground water.

The following milestones were used to assess progress towards meeting the selenium water quality objectives in the two sloughs.

MAXIMUM MONTHLY MEAN SELENIUM CONCENTRATIONS

TIME PERIOD	MUD SLOUGH (NORTH) SALT SLOUGH
WY 90 (10/89 - 9/90)	20 μg/L
WY 91 (10/90 - 9/91)	17 μg/L
WY 92 (10/91 - 9/92)	15 μg/L

Although both sloughs exceeded the 1993 selenium water quality objective (10 μg/L) during WY 91, only Salt Slough consistently exceeded the WY 91 selenium milestone of 17 μg/L (Figure 9). Monthly mean selenium concentrations in Salt Slough reached a maximum (24 μg/L) in February 1990 and stayed above 17 μg/L from December to June 1991. Selenium concentrations dropped sharply in June 1991 when the majority of subsurface drainage water was diverted to Mud Slough (north). This sharp decrease was accompanied by a simultaneous increase in concentration in Mud Slough (north). Mud Slough reached its maximum monthly mean selenium concentration in July 1991 at 37 μg/L showing that little dilution water exists in the Slough.

Figure 7. Mean Monthly Molybdenum Concentrations in Mud Slough (North) at the San Luis Drain and Salt Slough at Lander Avenue for WY 91.

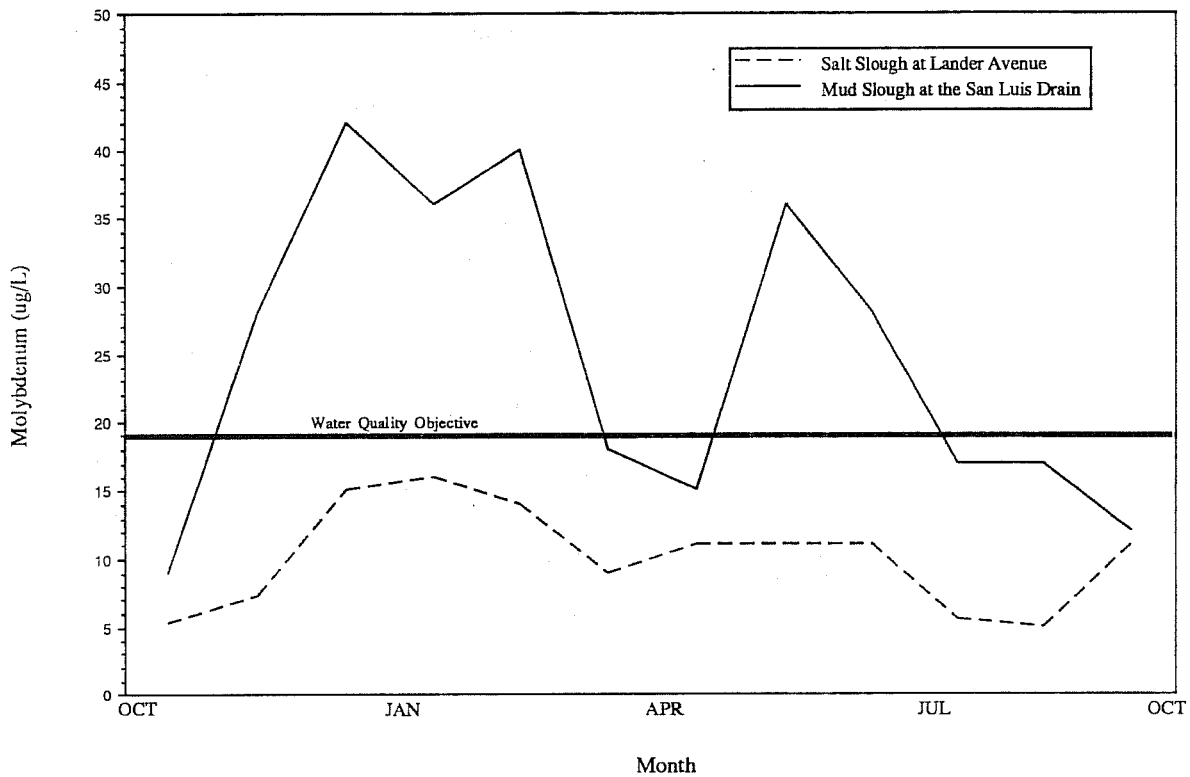
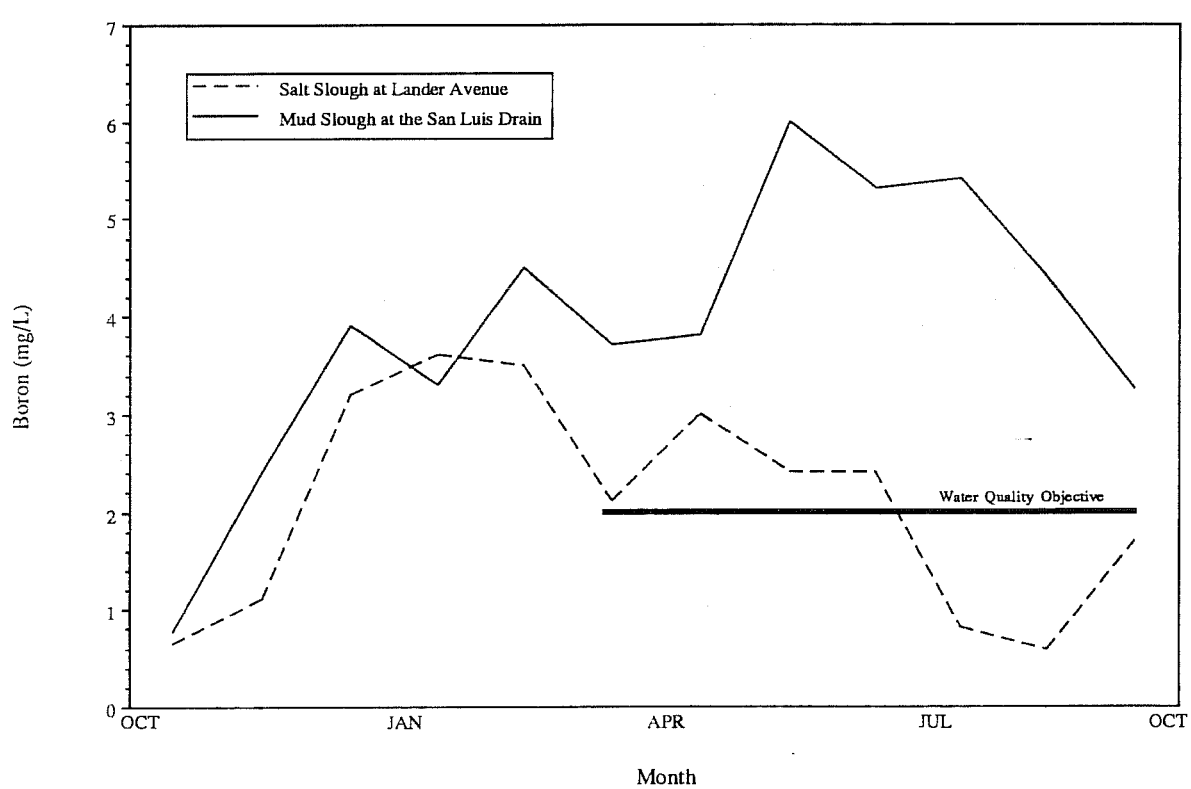


Figure 8. Mean Monthly Boron Concentrations in Mud Slough (North) at the San Luis Drain and Salt Slough at Lander Avenue for WY 91, as Compared to the Adopted Water Quality Objective.



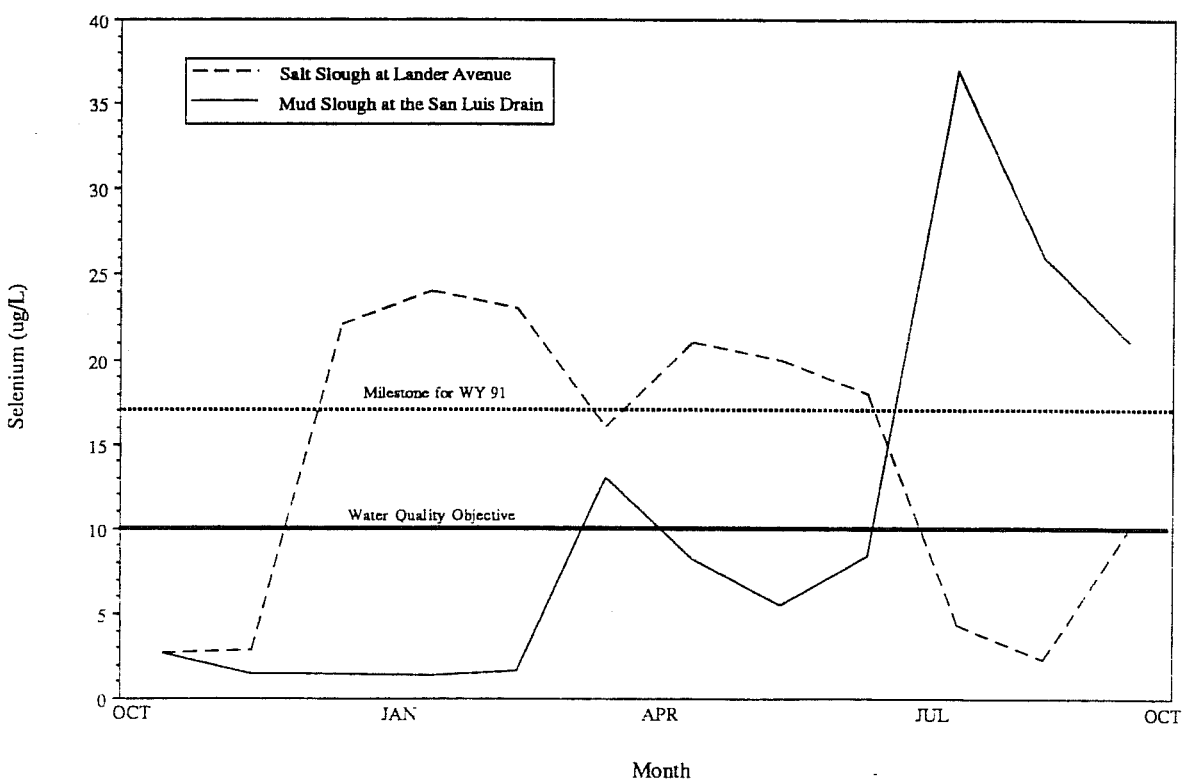
The 1993 selenium water quality objective (10 μg/L) was exceed in Salt Slough during all but three months in WY 91. The 1993 objective was exceeded in Mud Slough during four months in WY 91. The 1993 maximum selenium concentration objective (26 μg/L) was exceeded twice during the summer in Mud Slough (north) with concentrations reaching 37 μg/L. Salt Slough did not exceed the maximum concentration.

Continuing drought conditions during WY 92 may increase the difficulties in meeting future milestones and objectives adopted and approved for both sloughs. The monthly mean concentrations of boron, molybdenum, and selenium will continue to be reviewed in future water years.

SAMPLING FREQUENCY

The monitoring program for the Grassland Area was conducted weekly during WY 91. The data presented in this report is based on these weekly samples. There was concern expressed that the weekly sampling would not adequately represent conditions during critically dry-low flow periods, such as WY 91, a fifth consecutive critically dry year. Because of this concern, an intensified sampling program was conducted during the irrigation season (1 May - 30 September). Samples were collected at least 3 days per week during this period. Figures 10, 11 and 12 show a comparison of the weekly selenium data with that from a weekly average selenium concentration using the more frequent sampling period. For all three sites, the two data sets are closely comparable. A comparison of the monthly mean for the three sites for selenium, boron and electrical conductivity is shown in Table 5. The change in collection frequency did not significantly change the monthly mean at any of the sites.

Figure 9. Mean Monthly Selenium Concentrations in Mud Slough (North) at the San Luis Drain and Salt Slough at Lander Avenue for WY 91, as Compared to the Adopted Water Quality Objective.



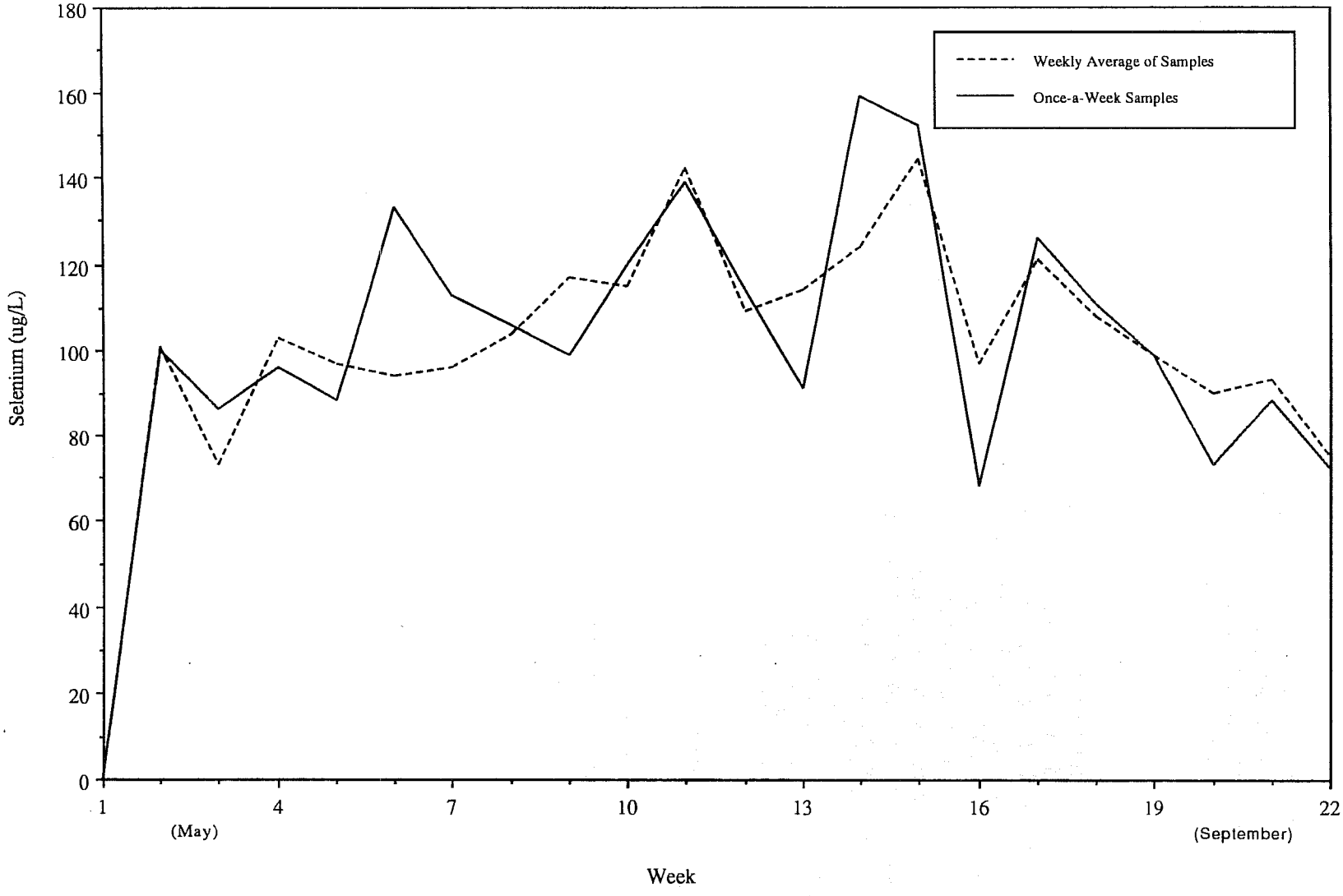


Figure 10. Selenium Concentrations at Hamburg Drain near Camp 13 Slough During the Drainage Season Collected Once-a-Week and a Weekly Average Determined From Samples Taken More Than Once-a-Week.

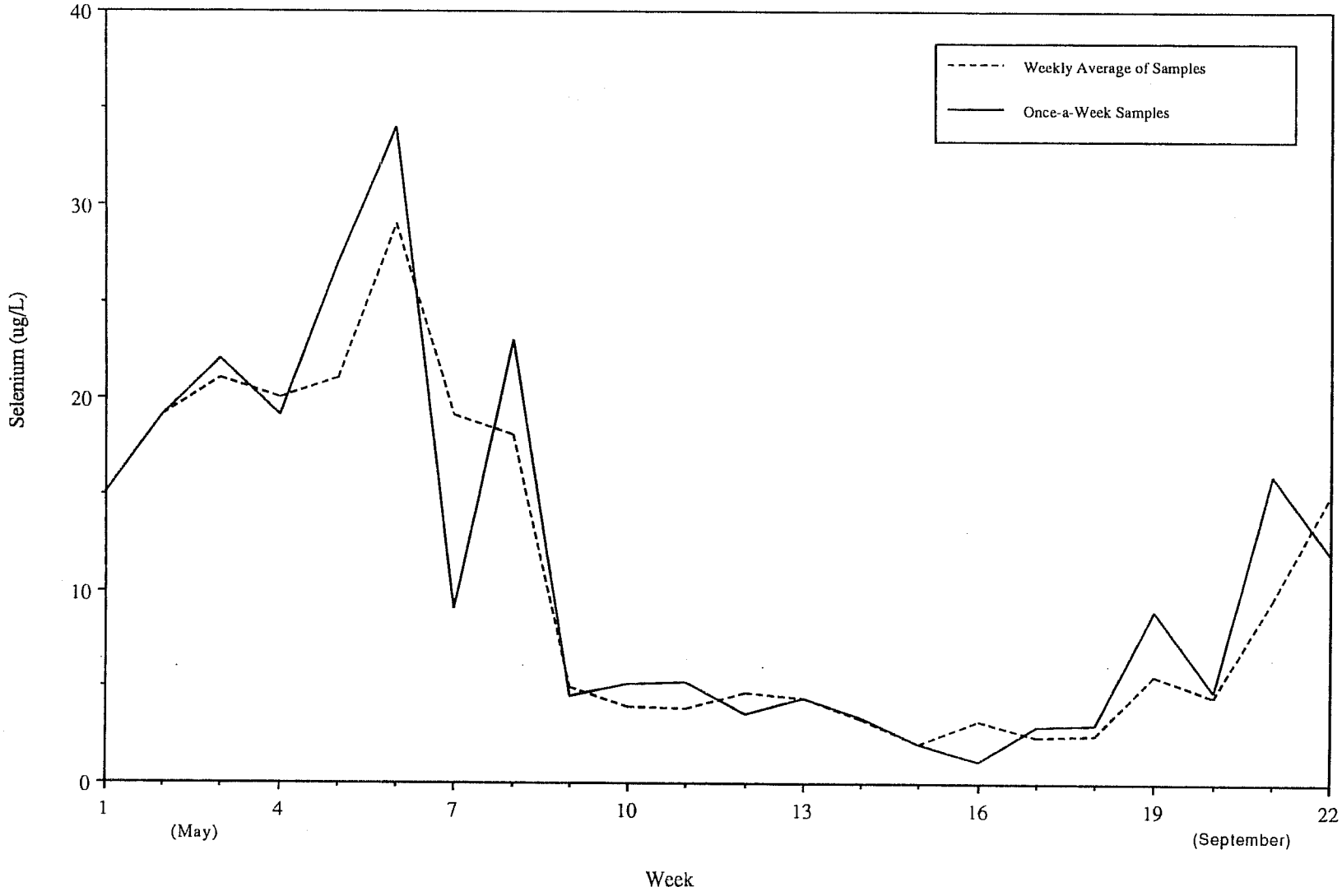


Figure 11. Selenium Concentrations at Salt Slough at Lander Avenue During the Drainage Season Collected Once-a-Week and a Weekly Average Determined From Samples Taken More Than Once-a-Week.

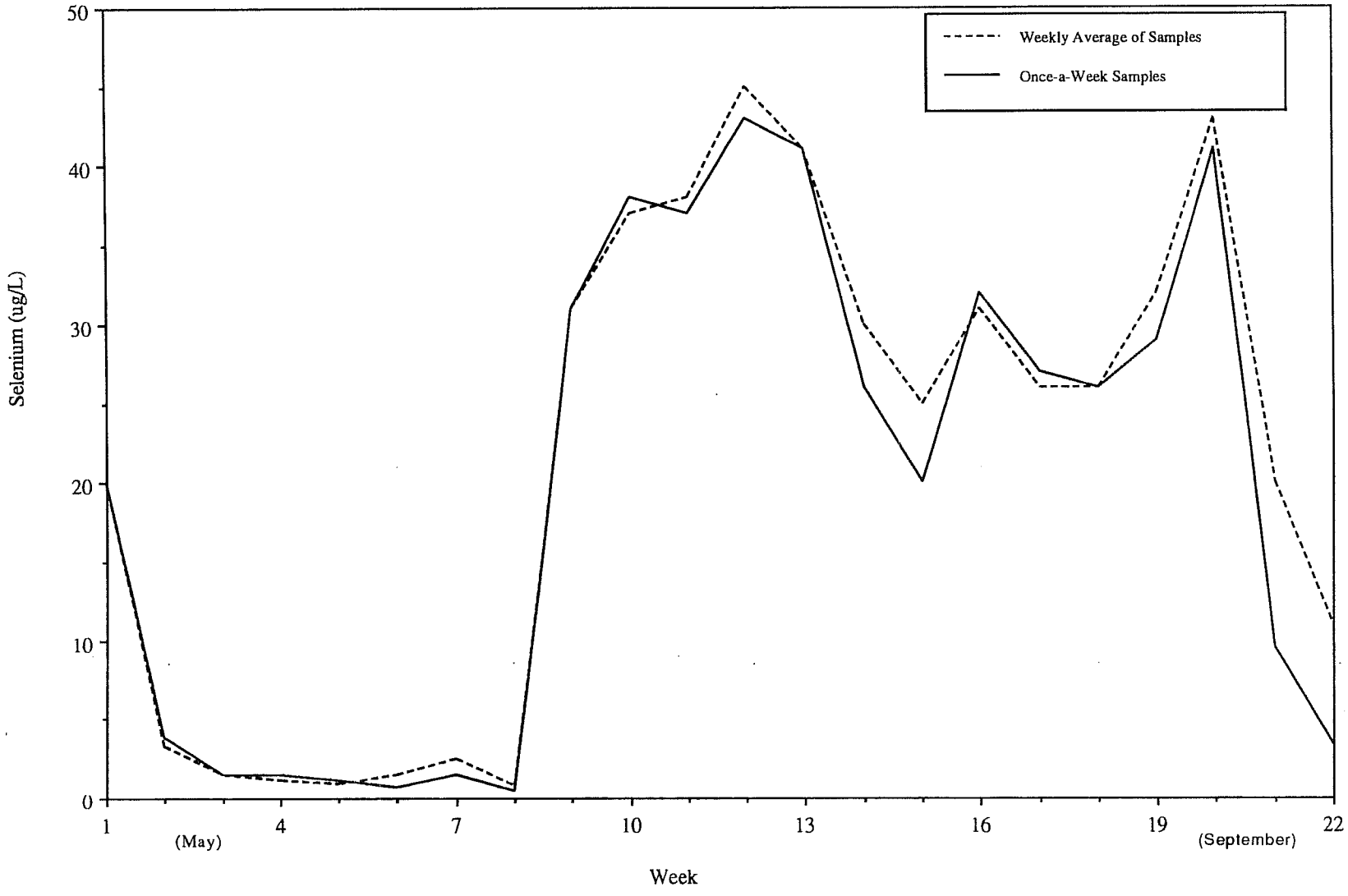


Figure 12. Selenium Concentrations at Mud Slough at San Luis Drain During the Drainage Season Collected Once-a-Week and a Weekly Average Determined From Samples Taken More Than Once-a-Week.

Table 5. Monthly Mean Concentrations for Electrical Conductivity, Boron and Selenium Using Samples Collected Weekly as Compared to Samples Collected More Frequently for the Time Period May Through September, 1991.

Electrical Conductivity (umhos/cm)

Site	May	June	July	August	September
Hamburg Drain	5520 5490	5720 5690	6020 5930	5430 5460	4670 4730
Mud Slough @ San Luis Drain	7890 8310	7370 7270	3590 3680	3060 3000	2240 2640
Salt Slough @ Lander	2670 2590	2350 2450	1570 1500	1290 1260	2030 1780

Boron (mg/L)

Site	May	June	July	August	September
Hamburg Drain	5.4 5.4	6.0 6.0	6.3 6.3	5.9 6.0	5.0 5.0
Mud Slough @ San Luis Drain	6.0 6.1	5.3 5.4	5.4 5.5	4.4 4.3	3.3 3.7
Salt Slough @ Lander	2.4 2.3	2.4 2.4	0.81 0.71	0.57 0.58	1.7 1.4

Selenium (ug/L)

Site	May	June	July	August	September
Hamburg Drain	93 95	113 103	125 122	114 117	83 86
Mud Slough @ San Luis Drain	5.5 3.3	8.4 8.3	37 39	26 27	21 26
Salt Slough @ Lander	20 20	18 18	4.3 4.1	2.3 2.6	11 9.2

Weekly Data
All Data

REFERENCES

Chilcott, J.E., Westcot, D.W., Werner, K.M., and Belden, K.K., 1988. *Water Quality Survey of Tile Drainage Discharges in the San Joaquin River Basin.* Agricultural Unit, Central Valley Regional Water Quality Control Board.

Chilcott, JE., Westcot, D.W., Belden, K.K., and O'Connor. K.A., 1989. *Agricultural Drainage Contribution to Water Quality in the Grassland Area of Western Merced County, California: October 1987 through September 1988.* Regional Water Quality Control Board, Central Valley Region Report, 44 pages.

Deverel, S.J., Gilliom, R.J., Fujii, R., Izbicki, J.A., and Fields, J.C., 1984. Areal Distribution of *Selenium and Other Inorganic Constituents in Shallow Groundwater of the San Luis Drain Service Area, San Joaquin Valley, California: A Preliminary Study.* U.S. Geological Survey Water Resource Investigation 84-4319, 67 pages.

EPA (U.S. Environmental Protection Agency) 1985. *Water Quality Criteria.* Federal Register, v.50, n.145. Washington D.C.

James, E.W., Westcot, D.W., Grewell, B.J., Belden, K.K., Boyd, T.F., Waters, R.I., and Thomasson, R.R., 1988. *Agricultural Drainage Contribution to Water Quality in the Grassland Area of Western Merced County, California.* Central Valley Regional Water Quality Control Board Report, 169 pages.

Lowry, P.A., Schnagl, R.J., and Gonzalez, J.L., 1989. *Ground Water Quality in the South Grassland Area of the Western San Joaquin Valley, California.* Agricultural Unit, Central Valley Regional Water Quality Control Board.

Marshack, J.B., 1988, personal communication. Central Valley Regional Water Quality Control Board, 3443 Routier Road, Sacramento, CA 95827.

Pierson, F.W., James, E.W. and Thomasson, R.R., 1988a. *Hydrology Study of Mud Slough (North), Merced County.* Agricultural Unit Central Valley Regional Water Quality Control Board.

Pierson, F.W., James, E.W. and Thomasson, R.R., 1988b. *Hydrology Study of Salt Slough, Merced County.* Agricultural Unit, Central Valley Regional Water Quality Control Board.

Westcot, D.W., Chilcott, J.E., and Enos, C.A., 1991. *Agricultural Drainage Contribution to Water Quality in the Grassland Area of Western Merced County, California: October 1990 through September 1990 (Water Year 1990).* Regional Water Quality Control Board, Central Valley Region Report.

Westcot, D.W., Chilcott, J.E., Enos, C.A., and Rashmawi, E.A., 1990. *Agricultural Drainage Contribution to Water Quality in the Grassland Area of Western Merced County, California: October 1988 through September 1989 (Water Year 1989).* Regional Water Quality Control Board, Central Valley Region Report.

APPENDIX A

Mineral and Trace Element Water Quality Data for Inflow Monitoring Stations
Listed in Order by Map Index Number

Map Index I-1. Main (Firebaugh) Drain at Russell Avenue (MLR33)

Location: Latitude 36° 55'27", Longitude 120°39'11". In SW 1/4, SW 1/4, SW 1/4, Sec. 34, T.11S., R.12E. E side of Russell Avenue., 2.7 mi. S of South Dos Palos.

Date	Time	pH	EC µmhos/cm	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp. °F
								µg/L									
0/26/90	835	7.8	6570	154	61	5	11	<5	11	18	16	17	12	810	2300	1400	61
1/27/90	830	7.9	7870	205	51	8	20	<5	12	11	26	12	12	910	3100	1800	44
2/28/90	1050	7.6	9090	286	75	<1	13	<5	<5	4	23	7	16	1200	2000	2000	34
1/25/91	1150	7.8	3635	88	22						12	9	5.2	400	1000	780	44
2/22/91	930	9.4	6305	68	14	1	9	<5	16	10	5	18	21	500	3100	2000	55
3/28/91	930	7.9	3660	70	11	23	70	7	62	89	15		3.8	350	1400	980	58
4/25/91	2010	7.8	2975	48	20	8	13	<5	17	17			3.8	320	870	650	69
5/9/91	920	7.7	3410	51									4.5				56
5/16/91	905	8.0	4420	70									6.5				64
5/23/91	1400	8.1	4360	81									6.4				76
5/30/91	1650	8.8	3830	63	26	11	25	<5	25	31			5.4	400	1400	820	68
6/7/91	815	7.7	3290	38	20								4.2				64
6/14/91	1345	7.8	3140	39	17								3.7				70
6/21/91	650	7.5	3400	45	25								4.2				64
6/28/91	655	7.8	3300	52		19	28	<5	30	50			4.6	420	1200	780	66
7/5/91	1310	8.1	3560	54									4.7				84
7/12/91	645	7.3	3300	42									4.2				72
7/19/91	1420	8.4	3010	40		14	35	<5	28	23			4.0	680	1300	1200	74
7/26/91	1415		2620	36									3.3				78
7/31/91	825		3010	42	14	11	41	<5	28	47			3.9	340	920	640	75
8/9/91	910	8.8	2600	30									3.5				75
8/16/91	755		2780	35									3.9				69
8/23/91	820		2880	34									3.8				70
8/30/91	830	7.9	3490	53	19	14	33	<5	30	4			4.8				74
9/7/91	1305	7.9	4430	76									6.9				78
9/14/91	905	7.7	3310	47									4.4				70
9/21/91	1245	8.0	4940	108									8.2				76
9/30/91	940	7.7	4000	47	46	6	5	<5	12	8			6.9	460	1400	900	70
Count		24	28	28	14	12	12	12	12	12	12	6	5	28	12	12	12	28
Min		7.3	2600	30	11	<1	5	<5	<5	<5	4	5	7	3.3	320	870	640	34
Max		9.4	9090	286	75	23	70	7	62	89	26	26	18	21	1200	3100	2000	84
Mean		8.0	4042	72	30	10	25	<5	23	26	17	16	13	6.3	566	1666	1163	66
Geo Mean		8.0	3822	60	25	6	20	<5	17	17	18	14	12	5.5	516	1519	1068	65
Median		7.9	3450	52	21	10	23	<5	21	18	16	12	12	4.6	440	1400	940	70

Map Index I-2. Panoche Drain at O'Banion Gauge Station (MER501)

Location: Latitude 36°55'27", Longitude 120°41'19". In SW 1/4, SW 1/4, SW 1/4, Sec. 32, T. 11S., R.12E. Located 0.5 mi. S of CCID Main Canal, 1.9 mi. W of Russell Rd., 5.5 mi. SW of Dos Palos, 3.4 SW of South Dos Palos.

Date	Time	pH	EC µmhos/cm	Se	Mo	Cu	Cr	Pb µg/L	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp. °F
10/26/90	850	7.8	4290	61	7	1	16	<5	<5	8	9	7	7.9	540	1100		57
11/27/90	855	8.0	4280	65	10	6	27	<5	<5	6	10	7	6.7	540	1100		44
12/28/90	1010	7.7	4720	84	8	<1	17	<5	<5	4	11	5	7.3	620	1300	1200	40
1/25/91	1215	7.5	4430	62	4						9	5	8.1	580	1100	1100	52
2/22/91	910	8.7	4335	61	5	4	43	<5	11	9	11	9	7.0	610	1300		54
4/25/91	1955	8.0	4820	99	10	4	16	<5	9	7	13	11	8.4	620	1300		68
5/9/91	945	7.7	4570	70									7.8				56
5/16/91	920	7.9	4370	56									6.8				64
5/23/91	1415	8.2	4860	77									7.9				80
5/30/91	1625	8.9	4890	106	10	3	32	<5	8	7	14	7	7.8	640	1400		70
6/7/91	830	7.6	4570	57	8								7.0				64
6/14/91	1400	7.9	4600	66	12								7.5				76
6/21/91	705	7.4	4370	34	8								6.7				58
6/28/91	710	7.8	4170	56		14	35	<5	28	23	11	8	7.3	680	1300		64
7/5/91	1320	8.0	4450	41									7.2				86
7/12/91	715	7.4	4640	63									7.2				68
7/19/91	1405	8.2	4510	71									7.8	670	830		78
7/26/91	1405		4240	54									7.0				84
7/31/91	840		3860	31	6	3	22	<5	9	8	7	8	6.5	590	1000		70
8/9/91	850	8.8	4280	82									7.6				73
8/16/91	815		3990	44									7.6				68
8/23/91	830		4350	43									6.8				68
8/30/91	845	7.8	4680	65	13	2	14	<5	5	<1	13	4	7.5				73
9/7/91	1330	8.1	4450	99									6.8				82
9/14/91	915	7.6	4660	64									7.9				70
9/21/91	1255	8.0	5050	124									8.3				78
9/30/91	950	7.7	5180	104	15	<1	<1	<5	<5	4	11	10	8.0	750	1600	1200	72
Count		23	27	27	13	10	10	10	10	10	11	11	27	11	11	4	27
Min		7.4	3860	31	4	<1	14	<5	<5	<1	7	4	6.5	540	830	1100	40
Max		8.9	5180	124	15	14	43	<5	28	23	14	11	8.4	750	1600	1200	86
Mean		7.9	4504	68	9	4	22	<5	8	8	11	7	7.4	622	1212	1167	67
Geo Mean		7.9	4495	65	8	2	15	<5	4	5	11	7	7.4	619	1195	1166	66
Median		7.9	4450	64	8	3	20	<5	7	7	11	7	7.5	620	1300	1200	68

Map Index I-3. Agatha Inlet (Mercy Springs) Drain near Panoche Drain (MER552)

Location: Latitude 36°56'01", Longitude 120°42'05". In SE 1/4, SE 1/4, NW 1/4, Sec. 31, T. 11S., R.12E. S of Firebaugh Drain, 2.6 mi. W of Russell Ave., 2.8 mi. S of South Dos Palos.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm					µg/L									°F
10/26/90	900	7.6	6600	2.3									13	960	2100	1800	53
12/28/90						– INACCESSIBLE –											
1/25/91						– INACCESSIBLE –											
2/22/91						– INACCESSIBLE –											
3/28/91						– INACCESSIBLE –											
4/25/91	2000	8.1	4750										8.2	640	1300	1200	71
5/9/91	1000	7.9	6080	5.1									12				64
5/16/91	930	8.1	4300	8.0									7.0				66
5/23/91	1425	8.3	3970	8.1									6.7				88
5/30/91	1640	9.0	5080	8.6									9.7	730	1600	1200	71
6/7/91	840	7.7	4480	6.6									7.2				66
6/14/91	1405	7.8	4270	6.0									7.6				80
6/21/91	715	7.6	3770	4.3									6.0				62
6/28/91	720	7.8		4.7									6.5	670	830	770	64
7/5/91	1335	8.1	3360	4.7									5.7				92
7/12/91	705	7.2	3960	4.8									6.8				72
7/19/91	1350	7.8	3370	3.7									6.2	420	890	740	78
7/26/91	1350		3020	3.6									5.3				86
7/31/91	845		3100	4.0									5.4	470	730	680	75
8/9/91	855	8.8	2730	5.2									5.2				74
8/16/91	830		2460	4.5									3.8				70
8/23/91	835		2970	3.7									4.6				68
8/30/91	850	7.9	1920	2.6									2.7				74
9/7/91	1315	8.1	2060	2.0									3.0				84
9/14/91	925	7.7	2670	3.2									3.8				72
9/21/91	1305	8.3	5870	6.9									14				88
9/30/91	955						– DRY –										
Count		18	21	21	0	0	0	0	0	0	0	0	22	6	6	6	22
Min		7.2	1920	2.0									2.7	420	730	680	53
Max		9.0	6600	8.6									14	960	2100	1800	92
Mean		8.0	3847	4.9									6.8	648	1242	1065	74
Geo Mean		8.0	3643	4.5									6.3	625	1153	1001	73
Median		7.9	3770	4.7									6.4	655	1095	985	72

Map Index I-4. Agatha Canal at Helm Canal (MER506)

Location: Latitude 36°56'04", Longitude 120°41'06". In NE 1/4, Se 1/4, NW 1/4, Sec. 31, T.11S., R.12E. 150 ft. N of Helm Canal, 2.6 mi. W of Russell Ave., 3.4 mi. SW of South Dos Palos.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm	µg/L													°F
10/26/90	815	8.2	630	1.6	1								0.18	100	53	120	63
11/27/90	800	7.9	4050	73	13								6.2	510	1100	950	50
1/25/91	1125	7.6	4430	61	4								7.8	710	1300	1200	50
2/22/91	850	8.6	4390	64	10								6.8	520	1200	1100	54
4/25/91	1945	7.9	4510	39	8								7.8	580	1200	1200	68
5/9/91	900	7.6	4250	60									6.2				54
5/16/91	900	7.8	4390	52									7.1				62
5/23/91	1345	8.3	4490	77									7.4				80
5/30/91	1610	8.5	4450	75	14								5.8	600	1300	1100	70
6/7/91	800	7.7	4340	57	11								7.1				62
6/14/91	1325	7.9	4490	61	13								7.2				74
6/21/91	630	7.6	4510	38	9								7.0				60
6/28/91	630	7.8	4160	59	8								6.1	680	1100	1100	64
7/5/91	1245	8.2	4370	40									7.3				82
7/12/91	730	7.5	4550	59									7.8				70
7/19/91	1435	7.8	4170	54									6.9	140	80	150	76
7/26/91	1435		3960	45									6.3				80
7/31/91	805		3540	29									5.9	490	1100	820	72
8/9/91	830	8.5	3400	37									5.6				72
8/23/91	800		2140	4.0									3.1				68
8/30/91	815	8.4	1620	2.2	4								2.0				75
9/30/91	925	8.0	630	1.9	2								0.23	130	68	120	76
Count		19	22	22	12	0	0	0	0	0	0	0	22	10	10	10	22
Min		7.5	630	1.6	1								0.18	100	53	120	50
Max		8.6	4550	77.0	14								7.80	710	1300	1200	82
Mean		8.0	3703	45.0	8								5.81	446	850	786	67
Geo Mean		8.0	3305	29.7	6								4.49	363	498	563	67
Median		7.9	4295	53.0	9								6.55	515	1100	1025	69

Map Index I-6. Hamburg Drain near Camp 13 Slough (MER504)

Location: Latitude 36°56'32", Longitude 120°45'23". In SE 1/4, SE 1/4, SW 1/4, Sec. 27, T.11S., R.11E.
50 ft. S of CCID main Canal, 9.2 mi. S-SE of Los Banos, 6.7 mi. W-SW of South Dos Palos.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm					µg/L									°F
10/26/90	750	7.4	3190	24	6	<1	1	<5	<5	<5	8	3	3.4	365	1300	1300	54
11/27/90	735	7.0	3440	32	5	3	8	<5	<5	5	8	2	2.6	345	1400	1400	36
12/28/90	855	8.0	5230	90	5	<1	11	<5	<5	5	13	7	5.7	710	1600	1600	42
1/25/91	1050	7.4	5520	109	6						21	3	7.1	770	1800	1750	54
2/22/91	815	8.6	5645	87	4	<1	14	<5	6	1			7.4	790	2000	1800	53
3/28/91	822	7.4	4870	85	9						18	9	4.6	720	1400	1500	60
4/25/91	1930	7.8	5590	104	5	2	14	<5	<5	4	20	8	6.0	755	1750	1700	71
5/9/91	820	7.4	5560	100									5.0				54
5/16/91	845	7.4	5340	86									5.1				62
5/23/91	1315	8.5	5590	96									5.6				76
5/30/91	1550	8.9	5590	88	7	1	13	<5	4	<1	20	5	5.9	740	1800	1800	69
6/7/91	740	7.4	6150	133	7								6.8				60
6/14/91	1310	8.0	5910	113	9								6.8				74
6/21/91	615	7.1	5600	106	4								5.0				58
6/28/91	605	7.2	5230	99	10	1	10	<5	7	10	20	6	5.3	850	1800	1800	62
7/5/91	1220	8.1	6120	120									6.1				84
7/12/91	750	7.6	6520	139									7.8				66
7/19/91	1455	8.3	5710	114	27								6.6	610	1300	890	80
7/26/91	1455		4760	91									4.5				86
7/31/91	750		7000	159	9	1	4	<5	<5	<1	33	6	6.3	950	2200	1700	66
8/9/91	815	8.1	5870	152									6.8				70
8/16/91	725		4440	68									4.8				65
8/23/91	745		5970	126									6.4				66
8/30/91	740	7.8	5440	111	8	1	13	<5	<5	<1	19	6	5.5				72
9/7/91	1230	7.9	5240	99									5.6				78
9/14/91	835	7.5	4300	73									4.5				66
9/21/91	1215	8.0	4740	88									5.0				76
9/30/91	910	7.6	4380	72	7	2	10	<5	6	7	14	8	5.0	640	1400	1400	70
Count		24	28	28	16	10	10	10	10	10	11	11	28	12	12	12	28
Min		7.0	3190	24	4	<1	1	<5	<5	<1	8	2	2.6	345	1300	890	36
Max		8.9	7000	159	27	3	14	<5	7	10	33	9	7.8	950	2200	1800	86
Mean		7.8	5319	99	8	1	10	<5	<5	3	18	6	5.6	687	1646	1553	65
Geo Mean		7.8	5248	93	7	1	8	<5	<5	2	16	5	5.5	661	1623	1527	64
Median		7.7	5540	99	7	1	11	<5	<5	3	19	6	5.6	730	1675	1650	66

Map Index I-7. Camp 13 Slough at Gauge Station (MER505)

Location: Latitude 36°56'04", Longitude 120°41'06". In SE 1/4, SE 1/4, SW 1/4, Sec. 27, T.11S., R.11E. 150 ft. N of CCID Main Canal, 6.4 mi. W of Russell Ave., 9.2 mi. SE of Los Banos, 6.7 mi. SW of South Dos Palos.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm					µg/L									°F
10/26/90	800	7.6	4530	70	10								8.3	600	1500		57
11/27/90	738	7.8	5750	120	27								8.8	680	2200		40
12/28/90	910	8.1	5500	106	15								5.4	710	1600	1400	38
1/25/91	1105	7.7	3860	66	11								5.5	470	1000	980	48
2/22/91	830	8.8	3555	55	21						24	7	4.0	460	1100		53
3/28/91	830	7.6	3980	69	5	<1	16	<5	9	8			4.3	480	1300		57
4/25/91	1940	7.8	3935	67	12								5.2	460	1200		69
5/9/91	835	7.6	4090	60									4.5				54
5/16/91	850	7.8	5220	106									8.6				64
5/23/91	1320	8.5	4960	67									7.2				76
5/30/91	1600	9.0	4390	59	24								5.1	520	1400		68
6/7/91	745	7.6	3930	49	30								5.1				66
6/14/91	1315	8.0	4440	60	27								6.2				74
6/21/91	620	7.4	4500	55	20								5.4				64
6/28/91	615	7.6	3740	42	27								4.8	610	1300		66
7/5/91	1230	8.3	4200	55									6.1				86
7/12/91	740	7.7	3890	50									6.1				72
7/19/91	1450	8.4	4040	49	8								6.4	680	1100		76
7/26/91	1450		3870	34									6.2				82
7/31/91	800		3240	33	21								4.4	420	870		76
8/9/91	820	8.4	3470	43									5.5				72
8/16/91	730		3360	31									5.4				66
8/23/91	750		3750	38									5.6				68
8/30/91	800	7.9	3710	45	9								5.3				74
9/7/91	1230	8.1	3870	51									5.8				78
9/14/91	845	7.6	3300	32									4.9				68
9/21/91	1220	8.1	4320	68									6.8				78
9/30/91	910	7.4	5110	68	31	4	17	<5	12	12			8.9	690	1700	1200	70
Count		24	28	28	16	2	2	2	2	2	1	1	28	12	12	3	28
Min		7.4	3240	31	5								4.0	420	870	980	38
Max		9.0	5750	120	31								8.9	710	2200	1400	86
Mean		7.9	4161	59	19								5.9	565	1356	1193	66
Geo Mean		7.9	4115	55	16								5.8	556	1315	1181	65
Median		7.8	3958	55	21								5.5	560	1300	1200	68

Map Index I-8. Charleston Drain at CCID Main Canal (MER502)

Location: Latitude 36°56'59", Longitude 121°46'55". In NE 1/4, SE 1/4, NE 1/4, Sec. 29, T.11S., R.11E.
N side of CCID Main Canal, 8.7 mi. S-SE of Los Banos, 7.9 mi. W-SW of South Dos Palos.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm					µg/L									°F
10/26/90	745	7.1	2010	21	2	4	9	<5	8	15	7		1.8	260	600	580	61
11/27/90	715	6.9	5130	84	5	5	11	<5	6	10	18		5.1	650	1800	1700	42
12/28/90	845	7.8	5910	92	10	<1	7	<5	<5	<1	26		6.3	680	3400	1800	44
1/25/91	1025	7.0	3635	58	1						20		3.2	480	1300	1100	45
2/22/91	745	8.7	5295	77	9	<1	8	<5	6	12	24		5.0	640	2000	1700	51
3/28/91	810	7.4	5130	97	8	<1	14	<5	8	10	25		4.1	660	1700	1600	56
4/25/91	1920	7.4	4080	68	5	5	11	<5	9	7	17		4.2	560	1500	1300	68
5/9/91	805	7.2	4100	45									3.9				54
5/16/91	835	7.1	5040	76									4.3				62
5/23/91	1315	8.5	3410	44									3.7				74
5/30/91	1540	8.7	4580	87	7	5	15	<5	9	15			4.0	570	1700	1500	69
6/7/91	730	7.1	4760	87	8								4.2				62
6/14/91	1300	7.7	4990	92	10								4.6				72
6/21/91	605	6.8	3960	58									3.2				62
6/28/91	555	6.8	4830	102	9	4	10	<5	11	30			3.7	670	2000	1700	64
7/5/91	1210	7.9	3970	57									3.8				80
7/12/91	800	7.8	3940	60									4.5				66
7/19/91	1505	8.7	4260	63	10	1	10	<5	7	10			4.1	850	1800	1800	80
7/26/91	1505		4370	70									4.2				80
7/31/91	740		5420	120	5	3	12	<5	7	15			5.6	750	1500	1600	70
8/9/91	800	9.0	3000	5.8									4.5				69
8/16/91	710		2780	6.6									3.3				70
8/23/91	735		4950	54									5.4				66
8/30/91	730	8.0	3900	39	7	3	7	<5	6	<1			4.0				74
9/7/91	1220	8.0	2000	13									2.4				74
9/21/91	1200	7.8	4940	60									4.8				72
9/30/91	900	7.3	4370	48	12	1	3	<5	5	11			4.6	580	1500	1400	69
Count		23	27	27	15	12	12	12	12	12	7	0	27	12	12	12	27
Min		6.8	2000	6	1	<1	3	<5	<5	<1	7		1.8	260	600	580	42
Max		9.0	5910	120	12	5	15	<5	11	30	26		6.3	850	3400	1800	80
Mean		7.7	4250	62	7	3	10	<5	7	11	20		4.2	613	1733	1482	65
Geo Mean		7.6	4118	51	6	2	9	<5	6	7	18		4.1	592	1623	1426	64
Median		7.7	4370	60	8	3	10	<5	7	11	20		4.2	645	1700	1600	68

Map Index I-9. Almond Drive Drain (MER555)

Location: Latitude 36° 59'55", Longitude 120°49'00". In SW 1/4, SW 1/4, SW 1/4, Sec. 6, T11S., R.11E. N side of Almond Dr., 1.1 mi. E of Mercy Springs Drain, 100 ft. E of CCID Main Canal, 4.7 mi. S of Los Banos.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm					µg/L									°F
10/26/90	725	7.5	650	0.5									0.21	100	57	130	63
11/27/90	700	7.1	830	1.3									0.61	340	250	410	38
12/28/90	830	8.6	1580	11									0.98	200	290	330	35
1/25/91	1000	6.3	1555	1.7									1.3	250	390	340	50
2/22/91	720	7.0	1145	1.4									0.86	130	180	240	50
3/28/91	745	7.8	980	2.1									0.46	170	150	200	56
4/25/91	1910	7.5	1030	1.8									0.96	130	180	220	68
5/9/91	745	7.0	1560	2.3									1.2				56
5/16/91	825	6.6	1960	4.4									1.7				60
5/23/91	1250	8.0	3530	8.4									3.5				74
5/30/91	1530	9.2	2270	4.8									2.1	270	510	570	68
6/7/91	715	6.9	2720	5.7									2.8				60
6/14/91	1245	7.6	2220	4.5									2.1				72
6/21/91	555	6.6	1420	4.0									0.89				60
6/28/91	535	6.7	1350	3.0									0.94	200	250	320	64
7/5/91	1200	8.1	2330	4.6									2.2				76
7/12/91	815	8.0	1290	3.0									0.89				68
7/19/91	1520	8.6	1300	2.4									1.0				80
7/26/91	1515		1150	3.3									0.79				84
7/31/91	725		1410	3.5									0.97	200	240	350	68
8/9/91							– DRY –										
8/16/91							– DRY –										
8/23/91	730		680	0.9									0.24				70
8/30/91	720	8.7	840	0.8									0.45				75
9/7/91							– DRY –										
9/14/91							– DRY –										
9/21/91	1150	8.2	1480	2.7									1.5				76
9/30/91	845	6.9	2360	1.8									3.4	300	530	430	70
Count		21	24	24	0	0	0	0	0	0	0	0	24	11	11	11	24
Min		6.3	650	0.5									0.21	100	57	130	35
Max		9.2	3530	11									3.5	340	530	570	84
Mean		7.6	1568	3.3									1.3	208	275	322	64
Geo Mean		7.5	1432	2.6									1.1	195	236	299	63
Median		7.5	1415	2.9									0.98	200	250	330	68

Map Index I-10. Rice Drain at Mallard Road (MER509)

Location: Latitude 36°59'22", Longitude 120°14'42". In NE 1/4, NW 1/4, SW 1/4, Sec. 7, T.11S., R.11E.
South of Santa Fe Grade at Brito, 50 ft. W of Mallard Rd., 4.5 mi. W of Dos Palos.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm	µg/L													°F
10/26/90	920	7.8	2380	2.0									4.6	280	540	520	60
11/27/90	920	8.1	5400	3.5	31								13	600	2100	1200	44
12/28/90	1110	7.8	5200	2.0	45								11	520	2100	1400	38
1/25/91	1255	8.0	4595										9.2	670	1400	1200	49
2/22/91	1010	9.1	3965	2.3	23								8.8	420	1500	980	55
3/28/91	1005	7.7	5670	3.0	35								14	710	1800	1400	60
4/25/91	2020	7.6	5090	4.6	22								14	560	2000	1200	69
5/9/91	1030	7.7	2350	3.5									4.7				62
5/16/91	945	8.2	2730	3.6									5.2				66
5/23/91	1445	8.1	2970	3.5									5.5				80
5/30/91	1705	7.9	2300	4.1	19								3.9	240	680	590	69
6/7/91	905	7.6	2540	3.6									3.5				66
6/14/91	1430	7.9	3340	2.8									6.9				78
6/21/91	740	7.8	3460	2.8	28								5.7				64
6/28/91	750	7.9	2830	3.5	15								5.2	420	890	740	64
7/5/91	1355	8.0	2620	2.3									4.2				86
7/12/91	620	7.0	2730	2.6									4.5				70
7/19/91	1330	8.2	2660	2.7									4.4	280	390	490	74
7/26/91	1330		2090	2.0									3.4				78
7/31/91	905		2510	2.9	11								4.3	300	760	610	74
8/9/91	925	8.6	2860	2.6									4.7				75
8/16/91	850		2520	2.3									4.9				70
8/23/91	850		2250	2.5									3.4				69
8/30/91	915	7.8	2530	2.3	13								4.5				74
9/7/91	1345	8.1	2280	1.8									3.8				80
9/14/91	940	7.9	1780	1.3									2.3				70
9/21/91	1325	8.5	2310	2.4									4.0				80
9/30/91	1015	8.0	1580	2.3	5								2.2	220	350	330	76
Count		24	28	27	11	0	0	0	0	0	0	0	28	12	12	12	28
Min		7.0	1580	1.3	5								2.2	220	350	330	38
Max		9.1	5670	4.6	45								14	710	2100	1400	86
Mean		8.0	3055	2.8	22								5.9	435	1209	888	68
Geo Mean		8.0	2886	2.7	19								5.2	403	1010	805	67
Median		7.9	2640	2.6	22								4.7	420	1145	860	70

Map Index I-11. Boundary Drain at Department of Fish and Game Pump (MER521)

Location: Latitude 37°06'32", Longitude 120°46'45". In NE 1/4, SE 1/4, NE 1/4, Sec. 32, T.9S., R.11E. North of Henry Miller Rd., 4.6 mi. NE of Los Banos.

Date	Time	pH	EC µmhos/cm	Se	Mo	Cu	Cr	Pb µg/L	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp. °F
10/26/90	1015	7.7	1080	0.9									0.37	180	130	220	62
11/27/90	1100	7.6	2070	0.2									0.31	130	79	130	50
1/25/91	1250	8.4	2130	0.5									0.62	350	290	430	50
2/22/91	1050	8.9	1770	0.9									0.58	290	200	340	58
4/25/91	805	7.0	1490	1.0									0.67	235	210	310	59
5/9/91	1325	7.2	1680	1.0									0.57				66
5/16/91	1020	7.8	1420	0.9									0.50				68
5/23/91	1200	7.5	1410	1.2									0.41				72
5/30/91	1355	8.5	1760	0.8									0.60	300	240	370	69
6/7/91	1505	7.6	1420	0.8									0.48				80
6/14/91	630	7.2	1300	1.3	4								0.45				60
6/21/91	1010	7.7	1380	0.8	5								0.38				68
6/28/91	850	7.6	1390	0.7									0.44	370	200	300	70
7/5/91	1110	7.6	1600	0.7									0.50				80
7/12/91	1420	7.7	1440	0.9									0.47				82
7/19/91	1225	8.2	1090	0.7									0.32	140	70	160	72
7/26/91	1225		1500	0.6									0.44				78
7/31/91	1030		1280	1.2									0.32	230	150	260	76
8/9/91	1015	9.0	1160	0.8									0.34				77
8/16/91	935		910	0.8	3								0.40				72
8/23/91	1045		1420	0.9									0.48				72
8/30/91	1010	7.5	1720	0.5									0.55				76
9/7/91	1120	7.8	1230	1.0									0.38				76
9/14/91	1045	8.1	960	1.4									0.29				74
9/30/91	1100	7.8	1010	0.5									0.29	190	97	190	75
Count		21	25	25	3	0	0	0	0	0	0	0	25	10	10	10	25
Min		7.0	910	0.2									0.29	130	70	130	50
Max		9.0	2130	1.4									0.67	370	290	430	82
Mean		7.8	1425	0.8									0.45	242	167	271	70
Geo Mean		7.8	1392	0.8									0.43	228	151	254	69
Median		7.7	1420	0.8									0.44	233	175	280	72

Map Index I-12. Salt Slough Ditch at Hereford Road (MER528)

Location: Latitude 37°08'30", Longitude 120°45'17". In NW 1/4, NE 1/4, NW 1/4, Sec. 22, T.9S., R.11E. 3.0 mi. N on Hereford Rd. from Henry Miller Rd.

Date	Time	pH	EC µmhos/cm	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp. °F
								µg/L									
10/26/90	1030	7.5	890	0.4									0.22	140	82	200	62
11/27/90	1116	7.7	1130	0.3									0.28	180	120	230	48
12/28/90	1200	7.8	1210	1.2									0.33	185	145	280	38
1/25/91	1235	8.8	1400	0.9									0.30	260	150	300	48
2/22/91	1110	8.9	1400	0.7									0.46	250	170	280	58
3/28/91	1105	7.8	1560	1.3									0.31	270	220	340	62
4/25/91	820	7.4	1145	0.8									0.41	160	140	270	58
5/9/91	1350	7.4	1365	0.9									0.49				66
5/16/91	1030	7.6	1110	1.0									0.39				68
5/23/91	1145	7.7	1040	1.4									0.38				74
5/30/91	1350	8.6	1120	1.3									0.42	150	120	250	68
6/7/91	1445	7.9	1360	1.1									0.44				78
6/14/91	645	7.3	890	1.0									0.29				64
6/21/91	955	7.9	1000	0.9									0.30				68
6/28/91	835	7.9	710	1.3									0.24	140	70	160	70
7/5/91	1055	7.9	1230	0.9									0.40				82
7/12/91	1405	8.4	980	0.9									0.28				80
7/19/91	1210	8.7	930	0.8	7	6	9	<5	12	16			0.27	190	290	340	72
7/26/91	1205		800	0.9									0.24				76
7/31/91	1015		1050	0.7									0.38	170	90	240	76
8/9/91	1025	8.5	1000	0.8									0.25				77
8/16/91	945		1060	1.3									0.34				73
8/23/91	1050		1030	1.0									0.29				75
8/30/91	1000	7.6	910	0.7									0.28				77
9/7/91	1110	8.3	1000	1.0									0.30				78
9/14/91	1055	7.7	920	1.1									0.25				76
9/21/91	1045	8.5	1180	0.8									0.35				74
9/30/91	1050	7.8	1040	0.4									0.28	180	97	220	78
Count		24	28	28	1	1	1	1	1	1	0	0	28	12	12	12	28
Min		7.3	710	0.3									0.22	140	70	160	38
Max		8.9	1560	1.4									0.49	270	290	340	82
Mean		8.0	1088	0.9									0.33	190	141	259	69
Geo Mean		8.0	1071	0.9									0.32	185	130	254	68
Median		7.8	1045	0.9									0.30	180	130	260	73

APPENDIX B

Mineral and Trace Element Water Quality Data for Internal Flow Monitoring Stations
Listed in Order by Map Index Number

Map Index T-1. CCID Main Canal at Russell Avenue (MER510)

Location: Latitude 36°55'28", Longitude 120°37'30". In SE 1/4, SE 1/4 SE 1/4, Sec. 33, T.11S., R.12E. 2.7 mi. S of Dos Palos.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm	µg/L													°F
10/26/90	830	8.1	630	0.6									0.17	100	53	120	63
11/27/90	830	8.4	890	1.2									0.48	140	110	150	44
12/28/90	1040	8.1	750	1.7									0.22	120	56	110	36
1/25/91	1155	8.0	985	2.1	2								0.43	140	120	200	50
3/28/91	920	8.1	1020	2.0									0.45	160	150	170	58
4/25/91	2010	8.1	545	2.2									0.30	60	74	120	69
5/9/91	920	7.9	710	2.4									0.38				60
5/16/91	905	8.4	680	1.8									0.38				64
5/23/91	1355	8.6	700	2.2									0.29				76
5/30/91	1650	8.8	690	1.3									0.30	94	76	150	68
6/7/91	810	8.0	690	2.1									0.29				66
6/14/91	1340	8.2	760	1.9									0.28				72
6/21/91	645	7.8	730	2.0									0.24				64
6/28/91	645	8.3	700	1.7									0.24	140	80	150	64
7/5/91	1255	8.6	780	1.5									0.25				84
7/12/91	635	7.5	740	0.8									0.25				70
7/19/91	1425	8.6	690	1.3									0.18				76
7/26/91	1420		710	1.4									0.22				82
7/31/91	820		710	1.4									0.18	130	60	140	74
8/9/91	905	8.8	700	0.8									0.19				74
8/16/91	750		690	1.0									0.25				69
8/23/91	815		710	1.2									0.28				70
8/30/91	825	8.2	760	0.6	2								0.28				75
9/7/91	1255	8.5	540	1.3									0.16				78
9/14/91	900	8.1	560	1.5									0.19				74
9/21/91	1240	8.4	650	1.6									0.21				78
9/30/91	935	8.0	780	0.9									0.29	130	91	150	74
Count		23	27	27	2	0	0	0	0	0	0	0	27	10	10	10	27
Min		7.5	540	0.6									0.16	60	53	110	36
Max		8.8	1020	2.4									0.48	160	150	200	84
Mean		8.2	722	1.5									0.27	121	87	146	68
Geo Mean		8.2	715	1.4									0.26	118	82	144	67
Median		8.2	710	1.5									0.25	130	78	150	70

Map Index T-7. San Luis Canal at HWY 152 (MER527)

Location: Latitude 36°03'03", Longitude 120°48'10".
In SE 1/4, SW 1/4, SE 1/4 Sec. 18, T.10S., R.11E.
N side of HWY 152, 2.5 mi. E of Los Banos.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm					µg/L									°F
10/26/90	945	8.1	700	0.9									0.26	96	54	140	64
11/27/90	940	8.2	2440	4.7									2.8	250	540	550	46
12/28/90	1130	8.2	3220	5.0									3.9	360	800	770	35
1/25/91	1315	7.9	2625	3.7									3.6	280	520	590	49
2/22/91	1030	9.0	2635	4.3									3.0	270	620	590	57
3/28/91	1020	7.8	2940	4.1									3.2	380	770	680	60
4/25/91	2035	7.6	1625	2.7									2.0	180	330	360	68
5/9/91	1050	7.7	1470	2.5									1.6				60
5/16/91	1000	8.1	2470	2.6									2.7				64
5/23/91	1500	8.0	2490	3.3									2.8				78
5/30/91	1720	8.7	1930	2.7									2.3	240	370	420	68
6/7/91	920	8.0	1050	2.3									0.74				68
6/14/91	1450	7.8	2320	4.1									2.3				74
6/21/91	755	7.8	1720	2.6									1.6				62
6/28/91	805	7.9	1900	2.7									1.8	280	390	490	68
7/5/91	1415	7.9	2460	3.1									2.0				82
7/12/91	600	6.9	1910	2.2									1.6				68
7/19/91	1310	8.5	1550	2.7									1.5	660	1300	1000	72
7/26/91	1315		1270	3.2									1.2				82
7/31/91	925		1300	2.4									0.93	180	200	290	72
8/9/91	945	9.2	1280	2.3									1.1				78
8/16/91	910		1140	1.6									1.1				71
8/23/91	905		1280	1.8									0.96				68
8/30/91	940	8.0	720	2.5									0.71				73
9/14/91	1000	7.8	1260	1.4									1.3				72
9/21/91	1340	8.4	790	1.3									0.48				78
9/30/91	1030	8.2	670	1.0									0.25	120	71	120	77
Count		23	27	27	0	0	0	0	0	0	0	0	27	12	12	12	27
Min		6.9	670	0.9									0.25	96	54	120	35
Max		9.2	3220	5.0									3.90	660	1300	1000	82
Mean		8.1	1747	2.7									1.77	275	497	500	67
Geo Mean		8.0	1590	2.5									1.44	243	362	426	66
Median		8.0	1625	2.6									1.60	260	455	520	68

APPENDIX C

Mineral and Trace Element Water Quality Data for Outflow Monitoring Stations
Listed in Order by Map Index Number

Map Index O-1. Mud Slough at Newman Land and Cattle Company (MER551)

Location: Latitude 37°18'33", Longitude 120°57'18". In NW 1/4, NW 1/4, SW 1/4, Sec. 23, T.7S., R.9E., 1.7 mi. NE of Santa Fe Grade, 1.2 mi. N of HWY 140, 4.2 mi. NE of Gustine.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm					µg/L									°F
10/5/90	1350	8.6	1290	4.2	6								0.80				80
10/12/90	1115	8.1	1000	3.1	9								0.64				62
10/19/90	1400	8.5	1130	2.9	13								0.73				68
10/26/90	1205	8.5	1420	2.9	10								1.0	210	260	270	68
11/2/90	1030	7.8	1880	2.2	16								1.3				50
11/9/90	710	8.0	2660	1.6	18								1.7				46
11/16/90	1210	8.1	4180	2.0	34								2.9				56
11/27/90	1304	8.5	4360	1.5	31								2.8	610	910	760	48
12/7/90	1055	7.8	4620	1.2	29								3.0				46
12/14/90	1040	7.5	5020	12	32								3.1				42
12/21/90	1035	8.0	5350	1.5	35								3.3				41
12/28/90	1105	8.0	3630	0.8	15								2.3	470	840	750	44
1/4/91	1145	8.2	3490	0.7	18								2.2				44
1/10/91	1515	8.2	3420	0.8	14								2.0				54
1/18/91	1105	7.8	3200	0.7									1.8				46
1/25/91	1050	8.5	4800	1.0									2.6	720	1100	890	50
2/1/91	1010	7.7	5000	1.1									3.4				46
2/8/91	1015	8.1	4840	1.5									3.3				51
2/15/91	1105	8.0	5160	1.6									3.6				58
2/22/91	1040	7.6	5770	1.8									3.8	850	1400	1000	61
3/1/91	1100		3600	1.5	19								2.4				56
3/8/91	1140	7.6	2860	3.9									2.2				58
3/15/91	1245	8.5	3620	6.0									3.0				53
3/21/91	720	7.2	3730	11									3.3				52
3/28/91	1310	7.7	2950	8.2									2.5	450	620	600	64
4/5/91	1145	8.2	3000	4.8									2.7				71
4/11/91	1515	8.2	3420	4.7									3.1				58
4/19/91	1040		4330	6.9									3.8				64
4/25/91	1115	7.8	4540	11									4.0	820	1200	870	64
5/2/91	1345	8.1	4790	6.2									3.7				64
5/9/91	1530	8.4	5140	4.5									4.2				72
5/16/91	1130	8.4	5820	2.2									4.3				76
5/23/91	945	8.5	5520	2.0									3.5				74
5/30/91	1120	9.6	4640	1.7									3.1	680	1200	1100	71
6/7/91	1245	8.4	6330	1.9									3.6				82
6/14/91	830	8.1	3490	2.0	11								2.4				70
6/21/91	830	8.6	3500	1.6	10								1.8				
6/28/91	930		3975	23									5.2	610	1100	850	68
7/5/91	850	8.1	3880	29									5.7				80
7/12/91	1150	8.3	3540	26									5.6				84
7/19/91	1000	7.9	3510	29	11	3	3	<5	6	5			5.0	410	320	460	78
7/26/91	955		3310	29									4.2				80
7/31/91	825		3480	26									4.8	440	900	800	76
8/9/91	1225	8.8	3000	27									4.5				82
8/16/91	1150		3200	30	14								4.6				77
8/23/91	840		3520	21									5.3				65
8/30/91	935	9.0	3130	23		3	8	<5	9	<1			4.3				75
9/7/91	920	8.2	3500	31									4.6				74
9/14/91	1235	8.1	3570	30									4.9				82
9/21/91	900	8.1	2640	17									3.2				70
9/30/91	1010	8.1	2500	4.0									1.7	390	480	440	71
Count		44	51	51	19	2	2	2	2	2	0	0	51	12	12	12	50
Min		7.2	1000	0.7	6								0.64	210	260	270	41
Max		9.6	6330	31	35								5.7	850	1400	1100	84
Mean		8.2	3730	9.2	18								3.2	555	861	733	63
Geo Mean		8.2	3493	4.5	16								2.9	521	767	686	62
Median		8.1	3540	3.9	15								3.2	540	905	780	64

Map Index O-2a. Mud Slough at San Luis Drain (MER542)

Location: Latitude 37°19'50", Longitude 120°57'03". In NW 1/4, NE 1/4, NW 1/4, Section 14, T.7S., R.9E.
5.0 mi. E of Gustine, 3.5 mi. SE of HWY 140, Located inside Kesterson N.W.R.

Date	Time	pH	EC µmhos/cm	Se	Mo	Cu	Cr	Pb µg/L	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp. °F
10/5/90	1320	8.2	870	3.1	4								0.46				72
10/12/90	1215	8.9	1050	2.4	12						4	11	0.69				62
10/19/90	1335	8.1	1100	1.9	10								0.68				68
10/26/90	1135	8.0	1500	3.1	11	4	9	<5	11	9	6	13	1.2	220	280	280	63
11/2/90	1100	8.0	1970	1.5	19								1.4				50
11/9/90	650	7.9	2800	1.4	21						5	8	1.9				48
11/16/90	1130	7.9	4280	1.5	34								3.0				54
11/27/90	1220	8.0	4780	1.0	36	2	3	<5	<5	3	6	5	3.2	660	1000	820	48
12/7/90	1210	8.1	5530	1.1	39								3.6				48
12/14/90	820	8.0	5320	1.5	36						6	7	3.7				42
12/21/90	1005	7.8	6170	1.8	47								3.8				39
12/28/90	1145	8.0	6350	1.1	44	<1	4	<5	<5	4	7	8	4.3	970	1500	1100	40
1/4/91	1240	8.4	5880	1.2	43								3.8				44
1/10/91	1425	7.8	6110	1.6	50						8	7	4.4				54
1/15/91	830	7.1	4910	1.3	37								3.4				51
1/18/91	1015	7.8	3510	0.9	23								2.1				46
1/25/91	1130	8.5	4550	1.3	27	3	7	1	8	8	7	8	2.9	680	930	810	46
2/1/91	1035	7.8	6110	1.0	38								4.5				46
2/8/91	925	7.8	5830	1.7	41						8	10	4.2				52
2/15/91	1030	7.8	6240	2.3	39								4.8				57
2/22/91	1115	7.8	6890	1.5	42	11	2	14	<5	10	7	11	4.6	1100	1800	1300	59
3/1/91	1130		6375	2.3									4.9				58
3/8/91	1225	7.6	3710	9.4							9	10	3.2				60
3/15/91	1040	8.6	2810	0.7	13								2.1				54
3/21/91	650	7.3	4030	31	18								4.5				52
3/28/91	1215	7.5	4100	24.0	23	3	8	<5	9	5	11	11	4.0	620	1200	840	63
4/5/91	1050	8.1	2980	5.5	11								2.8				67
4/11/91	1420	8.1	3320	5.5	10						8	14	3.0				56
4/19/91	1115		4640	6.9	18								4.4				64
4/25/91	1000	7.7	5140	15	20	<1	8	<5	9	7			4.9	780	1300	930	62
5/2/91	1255	7.8	5640	20	29								5.3				64
5/9/91	1455	7.9	6970	3.8									6.0				70
5/16/91	1210	7.9	8360	1.4	41								5.9				74
5/23/91	1035	8.1	9190	1.4	40								6.2				72
5/30/91	1235	9.1	9300	1.1	35	2	5	<5	5	6			6.4	1500	2500	1700	73
6/7/91	1330	8.0	9710	0.7	32								4.2				80
6/14/91	755	7.6	8890	1.5	30								5.9				64
6/21/91	900	8.2	>10000.00	0.5	35								6.0				
6/28/91	1010		3510	31	16	3	3	<5	6	3			5.1	550	1000	820	70
7/5/91	940	8.2	3820	38									5.7				82
7/12/91	1250	8.0	3760	37									6.3				84
7/19/91	1100	8.3	3770	43	19								5.8				74
7/26/91	1050		3400	41									4.7				82
7/31/91	910		3200	26	15	5	14	<5	12	2			4.4	410	900	710	78
8/9/91	1150	9.1	2440	20									2.9				84
8/16/91	1115		3070	32									4.7				76
8/23/91	925		3430	27									5.1				69
8/30/91	1120	9.1	3290	26	17								4.9	430	900	730	76
9/7/91	1000	8.3	3040	29									4.7				76
9/14/91	1200	8.2	3240	41	19								4.8				78
9/21/91	945	8.2	1510	9.5									1.7				72
9/30/91	1040	8.1	1180	3.3	5	<1	<1	<5	<5	4			1.8	190	98	220	72
Count		45	51	52	41	11	11	11	11	11	13	13	52	12	12	12	51
Min		7.1	870	0.5	4	<1	<1	<5	<5	2	4	5	0.46	190	98	220	39
Max		9.1	9710	43	50	11	14	14	12	10	11	14	6.4	1500	2500	1700	84
Mean		8.1	4501	11	27	3	6	<5	6	6	7	9	3.9	676	1117	855	63
Geo Mean		8.0	3912	4.3	23	2	4	<5	4	5	7	9	3.5	579	881	753	61
Median		8.0	4030	2.4	27	3	5	<5	6	5	7	10	4.4	640	1000	820	63

Map Index O-3. Los Banos Creek at HWY 140 (MER554)

Location: Latitude 37° 16'35", Longitude 120°57'14". In NE 1/4, SW 1/4, SW 1/4, Sec. 35, T.7S., R.9E. S side of HWY 140, 2.9 mi. NE of Gustine.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm					µg/L									°F
10/26/90	1140	7.8	2140	0.7									1.1	320	180	390	66
11/27/90	1230	8.5	2800	0.5	9								1.7	415	285	490	48
12/7/90	1140	8.4	3130	0.7									2.2				46
12/28/90	1135	8.1	3860	1.0									2.0	560	480	600	42
1/25/91	1120	8.7	4180	0.5									2.3	570	955	815	46
2/22/91	1110	8.0	3220	0.5									2.5	420	510	610	58
3/28/91	1231	7.7	2050	1.0									1.6	340	270	390	62
4/25/91	1020	7.9	3860	0.8									3.9	660	780	740	61
5/9/91	1515	8.2	4040	1.0									3.2				72
5/16/91	1150	8.8	3090	1.0									2.2				76
5/30/91							– DRY –										
6/7/91							– DRY –										
6/14/91							– DRY –										
6/21/91							– DRY –										
6/28/91							– DRY –										
7/5/91	925	8.3	1780	1.9									1.6				76
7/12/91	1230	8.8	1030	2.6									0.57				82
7/19/91	1035	8.4	1300	1.5	18								0.88	610	1100	850	76
7/26/91	1035		1010	2.5									0.58				78
7/31/91							– DRY –										
8/9/91	1205	9.5		2.1									0.77				80
8/16/91							– DRY –										
8/23/91							– DRY –										
8/30/91							– DRY –										
9/7/91							– DRY –										
9/14/91	1215	8.1	2690	1.0									1.3				76
9/21/91	930	8.3	1050	3.0									0.40				70
9/30/91							– DRY –										
Count		16	16	17	2	0	0	0	0	0	0	0	17	8	8	8	17
Min		7.7	1010	0.5									0.4	320	180	390	42
Max		9.5	4180	3.0									3.9	660	1100	850	82
Mean		8.3	2577	1.3									1.7	487	570	611	66
Geo Mean		8.3	2309	1.1									1.4	471	479	586	64
Median		8.3	2745	1.0									1.6	490	495	605	70

Map Index O-4. Salt Slough at Lander Avenue (HWY 165) (MER531)

Location: Latitude 37°14'55", Longitude 120°51'04". In NW 1/4, SE 1/4, SE 1/4, Sec. 10, T.8S., R.10E. 13.0 mi. N of Los Banos, 5.0 mi. S of HWY 140. Salt Slough at Lander Avenue

Date	Time	pH	EC µmhos/cm	Se	Mo	Cu	Cr	Pb µg/L	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp. °F
10/5/90	1250	7.1	1160	5.4	4								0.78				72
10/12/90	1250	8.2	1020	1.6	4						9	14	0.48				63
10/19/90	1300	7.0	1370	2.5	7								0.75				66
10/26/90	1100	7.5	1340	0.9	6	3	3	<5	<5	10	10	11	0.57	200	150	270	64
11/2/90	1130	8.4	1180	0.9	4								0.51				54
11/9/90	610	7.9	1460	4.6	6						9	13	1.0				50
11/16/90	1055	7.2	1760	4.1	8								1.3				56
11/27/90	1140	7.7	2290	1.4	11	2	3	<5	<5	3	12	6	1.4	335	370	455	48
12/7/90	1240	8.3	3200	19	15								3.0				49
12/14/90	750	8.5	3420	25	14						13	4	3.1				44
12/21/90	910	7.3	3760	23	16								3.5				38
12/28/90	1220	8.3	3370	21	14	<1	2	<5	<5	<1	12	3	3.0	480	710	740	40
1/4/91	1324	8.3	3250	15	13								2.8				46
1/10/91	1340	6.5	3810	27	17						11	4	3.9				54
1/15/91	915	7.7	3970	26	18								4.2				50
1/18/91	940	7.0	3560	22	15								3.5				47
1/25/91	1210	8.5	3690	30	15	1	3	<5	<5	4	11	2	3.7	510	860	890	48
2/1/91	1110	8.1	3440	12	15								3.1				48
2/8/91	845	7.5	3440	28	12						12	8	3.8				52
2/15/91	955	7.3	3390	27	14								4.0				57
2/22/91	1145	8.0	3280	23	14	2	1	<5	<5	<1	11	6	3.2	510	910	720	58
3/1/91	1230		2060	12	10								1.7				58
3/8/91	1340	7.5	3050	19	12						17	12	2.8				59
3/15/91	1126	6.9	2540	17	8								2.1				53
3/21/91	615	7.2	2470	20									2.0				52
3/28/91	1130	7.7	2480	13	7	7	16	<5	17	21	20		1.8	380	560	600	61
4/5/91	1010	7.3	2870	20	9								2.8				67
4/11/91	1328	7.3	3570	22	12						17	13	3.8				56
4/19/91	1155		3140	26	14								3.1				64
4/25/91	850	7.4	2265	16	10	5	13	<5	9	31			2.1	320	490	500	61
5/2/91	1205	7.1	2280	15	9								1.9				61
5/9/91	1420	7.5	2710	19	10								2.6				68
5/16/91	1050	7.9	2920	22	15								2.8				70
5/23/91	1120	8.4	2600	19	11								2.0				74
5/30/91	1330	8.8	2840	27	11	4	7	<5	7	10			2.9	390	660	690	69
6/7/91	1420	8.3	3350	34	17								4.6				78
6/14/91	710	7.3	1930	9.1	7								1.4				66
6/21/91	930	8.5	2450	23	12								2.7				
6/28/91	945	8.2	1650	4.5	7	6	9	<5	12	16			0.82	190	290	340	68
7/5/91	1030	8.2	1820	5.1									0.96				82
7/12/91	1335	8.4	1770	5.2									1.1				82
7/19/91	1140	8.8	1470	3.6	7								0.79	500	180	310	76
7/26/91	1140		1450	4.4									0.66				78
7/31/91	1000		1340	3.4	4	5	13	<5	12	24			0.55	200	190	270	78
8/9/91	1100	9.0	1100	2.0									0.32				80
8/16/91	1025		1090	1.1	2								0.38				74
8/23/91	1000		1440	2.9									0.78				70
8/30/91	1030	9.2	1510	3.0	8	2	3	<5	<5	<1			0.81	240	220	310	74
9/7/91	1045	8.5	1820	9.0									1.5				76
9/14/91	1120	7.6	1210	4.8	6								0.67				76
9/21/91	1025	8.4	2720	16									2.6				72
9/30/91	1145	8.5	2370	12	15	1	<1	<5	<5	5			1.9	410	500	460	78
Count		46	52	52	44	12	12	12	12	12	13	12	52	13	13	13	51
Min		6.5	1020	0.9	2	<1	<1	<5	<5	<1	9	2	0.32	190	150	270	38
Max		9.2	3970	34.0	18	7	16	<5	17	31	20	14	4.60	510	910	890	82
Mean		7.9	2412	14.0	11	3	6	<5	5	10	13	8	2.09	359	468	504	62
Geo Mean		7.8	2236	9.5	10	2	4	<5	<5	4	12	7	1.67	338	397	466	61
Median		7.9	2460	15.0	11	3	3	<5	<5	8	12	7	2.00	380	490	460	63

Map Index O-6. City Ditch (San Luis Wasteway to Mud Slough) (MER543)

Location: Latitude 37°07'44", Longitude 120°48'53". In SW 1/4, SW1/4, Sec. 19, T.9S., R.11E.
2.2 mi. N of Henry Miller Rd. along San Luis Canal.

Date	Time	pH	EC	Se	Mo	Cu	Cr	Pb	Ni	Zn	U	V	B	Cl	SO4	HDNS	Temp.
			µmhos/cm					µg/L									°F
5/23/91	1215	8.3	4650	63									7.6				74
5/30/91	1410	9.2	4720	71									6.6	620	1500	1200	70
6/7/91	1520	7.6	1120	2.8									0.82				78
6/14/91	610	6.9	3740	38									5.4				64
6/21/91	1030	7.6	3700	40									4.4				74
6/28/91	910	7.4	3910	46									6.8	660	1300	1000	70
7/5/91	1130	7.6	4230	49									6.6				86
7/12/91	1435	7.9	3890	47									1.2				82
7/19/91	1245	7.9	3790	41									5.9	370	200	300	74
7/26/91	1245		4130	57									6.2				80
7/31/91	1310		3280	31									4.3	400	950	740	82
8/9/91	1005	9.2	3150	34									4.8				78
8/16/91	925		3460	41									5.4				74
8/23/91	920		3280	30									4.6				72
8/30/91	1045	7.7	3520	37									5.2				80
9/7/91	1140	7.8	3110	31									4.7				78
9/14/91	1030	7.8	3320	41									4.7				74
9/21/91	1115	8.1	3550	46									5.1				74
9/30/91	1130	7.7	810	2.7									0.43	140	110	160	76
Count		15	19	19	0	0	0	0	0	0	0	0	19	5	5	5	19
Min		6.9	810	2.7									0.43	140	110	160	64
Max		9.2	4720	71									7.6	660	1500	1200	86
Mean		7.9	3440	39									4.8	438	812	680	76
Geo Mean		7.9	3210	32									4.0	385	527	532	76
Median		7.8	3550	41									5.1	400	950	740	74